S P E C T R A L
D Y N A M I C S

PUMA
BASIC

Sine
Operating Manual

2400-0124A

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Table of Contents

Table of Contents - Contd.

Table of Contents - Contd.

Table of Contents - Contd.

Table of Contents - Contd.

Table of Contents - Contd.

Chapter 1 - Introduction

1.1 Introduction

The Spectral Dynamics Computer Aided Test Suite (CATS) Vibration Control System (VCS) program is called PUMA BASIC. The current version is 1.8. This manual describes Sine Function vibration concepts and the operation of the Sine Function software for the PUMA Basic. Use this manual to operate the VCS with the Sine Function closed-loop data generation and signal synthesis program.

This manual is presented in eight chapters relating information about the applicable menus required to set up the operating parameters for the Puma Basic VCS Sine function.

1.2 Getting Started

Before beginning, read the PUMA *System Description Manual*. This will help familiarize the user with the system, and give required information for unpacking, assembly and operation.

1.3 Software and Manuals

Software and manuals (along with vendor manuals, calibration devices and service training) are sold in various combinations. There is also a Receiving Checkout Test (RCT) issued with the hardware.

1.3.1 Software

The Sine Function closed-loop vibration control program and options are supplied on diskette or CD ROM. This storage medium contains executable code for Sine Function, test parameters, schedule parameters and the micro code for peripheral devices.

1.3.2 Manuals

The PUMA BASIC VCS Sine Application is supplied with a set of two system manuals and an application manual.

- ***PUMA BASIC System Description***

  Part Number 2400-0100

Other manuals may be included as purchase options.

1.4 Sine Function Features

The PUMA BASIC VCS and the Sine Function program provide digital real-time closed loop shaker control for production testing, design qualification and reliability testing applications. The system allows the definition, simulation, and closed loop control of a Sine Function vibration excitation shaker system. The technical specifications of the Sine Function software are listed in Table 1-1.

Table 1-1. Sine Function Technical Specifications

Control Methods	
Control Loop	True analog-quality sine sweep with a double precision integrated phase algorithm for low distortion
Control Performance	
Dynamic Range	Greater than 80dB with 0.05 dB level step control over the full range.
Output Signal	Analog-quality digital sine generation, using a double precision integrated phase algorithm for low distortion.
Level Accuracy	Control to within ±1dB at a sweep rate of 1 oct/min through a 600 Hz resonance of a linear system with a Q of 70 with an internal 20% proportional tracking filter sweep frequency resolution of ±0.5% of the drive frequency.
Loop Time	Less than 5 msec for single channel control.
Compression Rate	Up to 3,500 dB/sec with unconditionally stable feedback control loop.
Harmonic Distortion	<-75 dB at full output
Reference Profile	
Definition	Up to 500 frequency segments
Segment Types	Constant displacement, velocity, acceleration and straight line acceleration (linear or logarithmic)
Crossover Frequencies	Automatically calculated to avoid segment boundary discontinuities
Alarm and Abort Limits	Independent positive and negative alarm and abort margins
Sweep Range	User-defined sweep range from 1 to 5,000 Hz; and 0.01 to 10,000 Hz (Premier Optional)
Sweep Resolution	User-defined resolution of 450 to 800 points per sweep; 450 to 2,400 points per sweep (Premier) optional
Spectrum Dynamic Limits	Acceleration range, maximum or minimum acceleration, maximum velocity and maximum displacement
Limit Profiles	
Definition	Up to 500 frequency segments
Segment Types	Constant displacement, velocity, acceleration and straight line acceleration (linear or logarithmic)
Crossover Frequencies	Automatically calculated to avoid segment boundary discontinuities

Number	Up to the number of active channels minus one

Table 1-1. Sine Function Technical Specifications - Contd.

Control Parameters

Mode of Operation	Manual, automatic
Test Duration	Maximum 10,000sweeps or 999:59:59 (hh, mm, ss); unlimited test
Measurement Processing	RMS, or tracking filter processing for all channels in parallel; processing type individually selectable for each channel
Tracking Filter Types	Proportional to drive frequency, 1 to 200% and fixed bandwidth, 1Hz to 1,000Hz
Transducer Types	Control based on acceleration or displacement transducer with programmable transition frequency band
Number of Control Channels	1 to all available channels, max 16
Multi-Channel Control Strategy	RMS, arithmetic average, min, max
Compression	5% to 100%
Units	M/s^2 – m/s – mm; g – in/sec – in; g – m/s – mm
Box Tolerance Enable	Alarm & Abort width set 1 to 100%
Startup/Shutdown Rate	0.1 to 999 dB/sec

Sweep Parameters

Sweep Mode	Linear, logarithmic
Sweep Duration	User defined, maximum 999:59:59 (hhh:mm:ss)
Number of Sweeps	0.01 to 100,000
Sweep-rate Linear	0.00003 to 300 Hz/sec (0.0018 to 18,000 Hz/min)
Sweep-rate Logarithmic	0.1 to 800 Oct/min
Initial Sweep Direction	Up, down
Sweep Type	Rate or Timed
Manual Sweep Control	Dwell, resume, reverse
Multiple Sweep-Rate Definition	100%; 50%; 25%; Arbitrary

Safety Features

Shaker Limits	Pretest verification that spectrum dynamic limits are within shaker operational limits (acceleration, velocity, displacement and voltage)
Loop Check Max. Drive	User-selectable, 1.0 to 1,000 mV RMS
Control Signal Loss	Continuous automatic detection.
Manual Abort	Graphical and keyboard abort buttons
Maximum Drive Signal	0.01 to 12 Vpeak
Startup/Shutdown Rates	Independently selectable, 0.1 to 999 dB/sec

Test Automation

Test Scheduling	User-defined sequence of up to 500 independent tests run automatically
Sweep-rate Table	Up to 50 sweep-rate vs frequency segments

Compression Table	Up to 50 compression speed vs frequency segments
Schedule Cycles	1 to 99

Table 1-1. Sine Function Technical Specifications - Contd.

Channel Setup	
Channel Type	Control, measure, reference, inactive
Sensitivity	0.001 to 99,999 m/Hg or mV/(m/s^2)
Channel Loop Check	Enabled, disabled
Channel Label	Up to 8 characters for each channel
Transducer Serial Number	Up to 10 characters for each channel
On-Line Analysis	
Display Functions	Control, drive, measurement channel 1 to 16, frequency response function (magnitude/phase or real/imaginary)
Cursors	X and Y value readout, peak search, trace
Scaling of Display	Log/linear, auto-scaled/fixed
Real-Time/Stored Data	Simultaneous display and overlay of real-time data and any stored data
Resonance Search & Dwell (Optional)	
Dwell Modes	Fixed frequency, phase tracked
Search Parameters	Max no. of resonances, hysteresis, minimum Q value
Resonance Calculation	Resonance frequency, Q, phase, level
Dwell Table Parameters	Duration, start frequency, dwell frequency, end frequency, dwell phase, alarm limit, abort limit
Data Storage	
Setup Options	Every sweep, last sweep, first sweep
Playback	Scan through the entire test data file, with adjustable delay and tagging
Documentation	
Test Summary	Fully documented post-test summary, easily printed or incorporated into any document using standard word processing software
Run Message Log	A text file records all system status messages displayed during test run.

1.4.1 Safety Features

Sine provides the following safety features to protect the operator, the test equipment and the manufacturing operations:

- Shaker Limits
- Password login to prevent unauthorized system operation
- Alarm / Abort messages to indicate abnormal test conditions

- Alarm / Abort tolerance limits set by the operator for each spectral line
- Total acceleration RMS Alarm / Abort level operator settings for the acceleration spectrum
- User specified active frequency range for Alarm / Abort conditions
- A loop check continuity test automatically precedes each test
- Drive signal clipping to prevent drive level from exceeding a threshold value
- Controlled test startup / shutdown rates
- Aborted testing for any control signal loss or excessive fluctuation
- Manual test abort
- Abort documentation for post-test analysis

1.4.2 Options

The following options may be purchased for use with the system.

1.4.2.1 Security

The Security Option package enables the system administrator to place limits on the system including who has access, what level of access is available to the user and whether or not access is available to people outside the facility.

1.4.2.2 Automation

The Automation Option package includes Remote Control Interface (RCI), Test Automation and Mission Simulation.

1.4.3 Compatible Equipment

The PUMA BASIC VCS connects to any commercially available electro-dynamic or electro-hydraulic shaker and amplifier.

1.4.4 Reliability

The PUMA BASIC VCS is designed and manufactured with state-of-the-art components and processes that improve the reliability of the system.

1.4.5 User Interface

To control the PUMA BASIC VCS, the user manipulates values on a high-resolution color graphics display with a mouse and keyboard. User help information is available for all program functions with a single keystroke or mouse click.

The color monitor provides real-time displays of:

- ❑ Program control menus
- ❑ Test definition parameters
- ❑ Spectra showing test conditions, with Abort / Alarm information

1.5 Starting The Program

The Spectral Dynamics CATS VCS program can be started by either a desktop shortcut icon or through the Start button. The latter path is: <Start>⇨**PROGRAMS**⇨**SPECTRAL TEST SUITE**⇨**PUMA BASIC.**

1.5.1 Log In

When initiated the **User Log In** Dialog Box (Figure 1-1) appears if the **Security** option is in place. If there is no Security option the PUMA BASIC Program Entry (Splash) Screen will appear as shown in Figure 1-2. To access the features of the PUMA BASIC VCS program the user must have a valid users name and password. See the system administrator for proper users name and password.

Enter a **User Name** and **Password** and click *<LOG IN>*. The PUMA Basic Splash Screen shown in Figure 1-2 will appear. It will disappear in several seconds (or can be dismissed by clicking on it) leaving the **New** Dialog Box. Click on **SINE,** and then click **OK**. A screen similar to the Spectral Dynamics Viewer (Graph Tool) Default Screen shown in Figure 1-3 appears. What is shown is the last test that was run and is dependent on the parameters previously set with the menu options under Puma Basic Local.

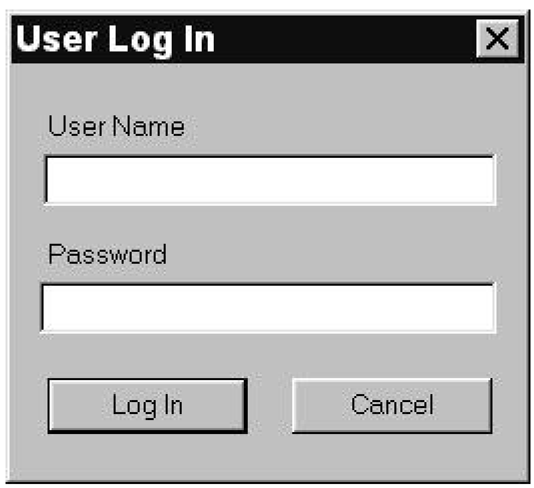


Figure 1-1. User Log In Dialog Box

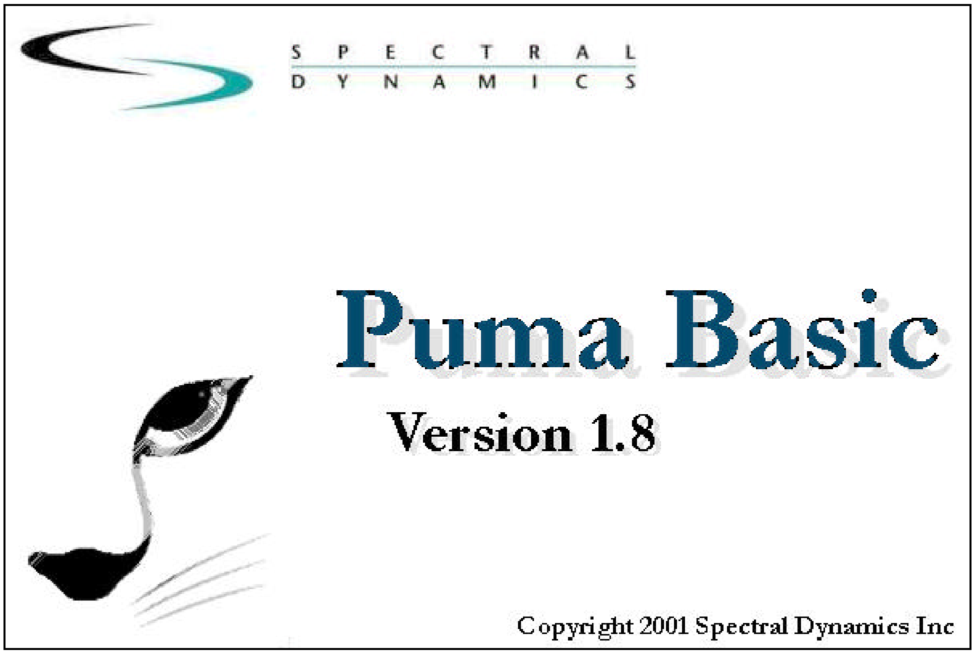


Figure 1-2. Puma Basic Splash Screen

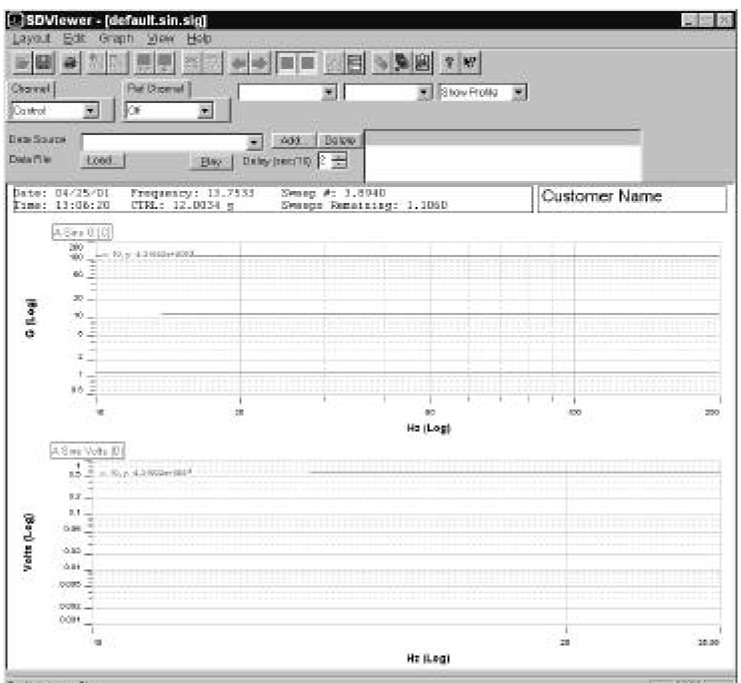


Figure 1-3. Graph Tool Default Screen

1.5.2 Puma Basic Local

The **Puma Basic Local** Window's **Title Bar** displays three segments of information. **Puma Basic** identifies the program that is running. **Local** indicates the mode that the program is running in and **Sine1** (or whatever the default program is) is the name of the test.

In order to initiate any type of test it must be done from the **Puma Basic Local** Window. To access it, minimize the Graph Tool Screen.

1.5.3 Sine Function Menus

The **Puma Basic Local** Window's **Sine Function Menu Bar** contains six menu selections used by the PUMA BASIC VCS program. They are: **FILE, SETUP, VIEW, TEST, DATA**, and **HELP**. Each of these is discussed further within their own chapter.

Using hotkeys can activate many of the menu selections. For instance use <ALT> +<F> to activate the FILE menu. An underlined letter indicates a Hot key.

Select **LOG OUT** from the **FILE** menu when the system is unattended, and access to the program is to be restricted. When logged in, the **LOG OUT** menu item is available (**LOG IN** is grayed out).

1.5.4 Setting Up Test Parameters

Initiating a test is done by either starting a new one from the very beginning or by running one that has already been set up and saved to a file.

1.5.4.1 New Test

The **SETUP** Menu information is presented in Chapter 4. The following procedure will enable the user to input test parameters using the **SETUP** Menu options.

Procedural Steps

1. On the PUMA BASIC Local Screen, click **SETUP⇨CHANNELS** or click the <Channel Setup> Button. The Channel Definition Window appears. See Figure 1-4.

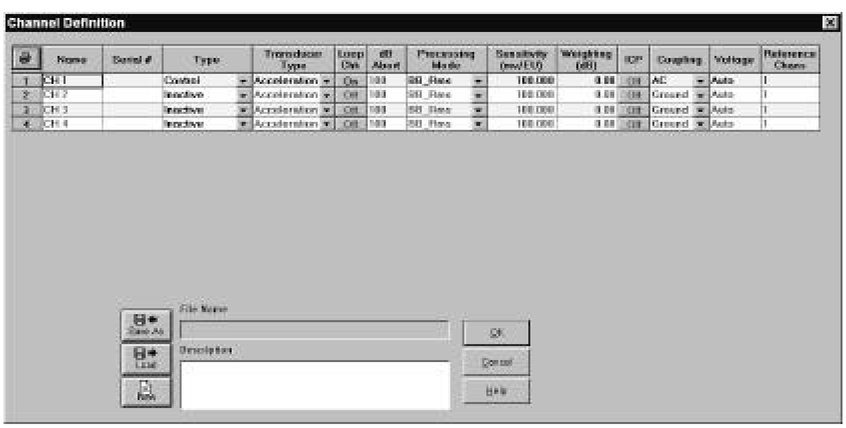


Figure 1-4. Channel Definition Window

2. Input the required parameters and save them to a file.
3. Click **S**ETUP⇨**P**ROFILES or click the <Profile Setup> Button. The Profile Settings Window appears. See Figure 1-5.
4. Input the required parameters and save them to a file.
5. Click **S**ETUP⇨**S**CHEDULES or the <**Setup Schedules**> Button. The Schedule Setup Window appears. See Figure 1-6.
6. Input the required parameters on the **SCHEDULE SETUP** Window and save them to a file.

The test is now ready to run.

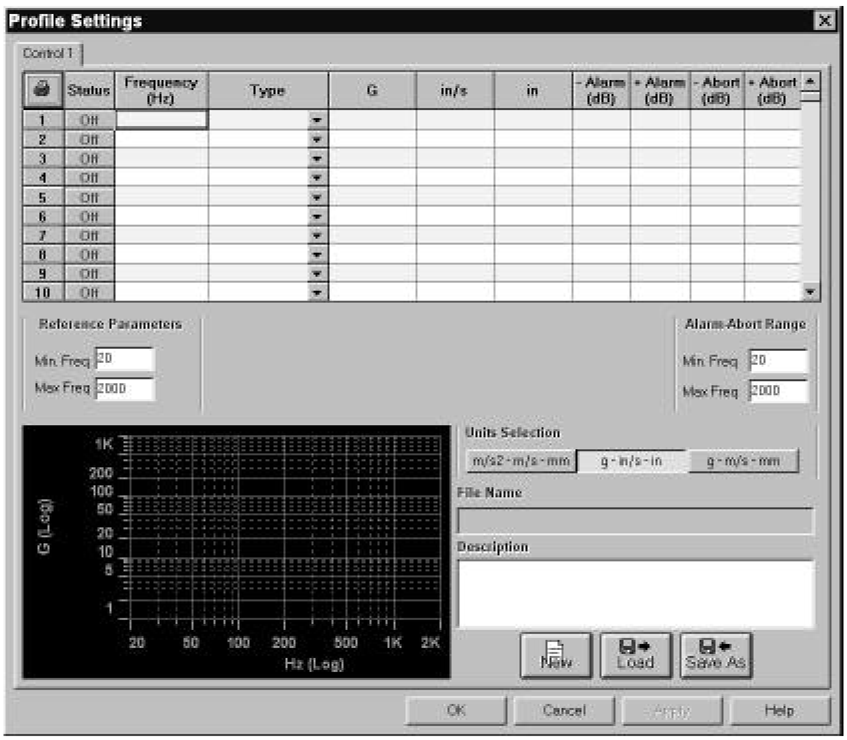


Figure 1-5. Profile Settings Window

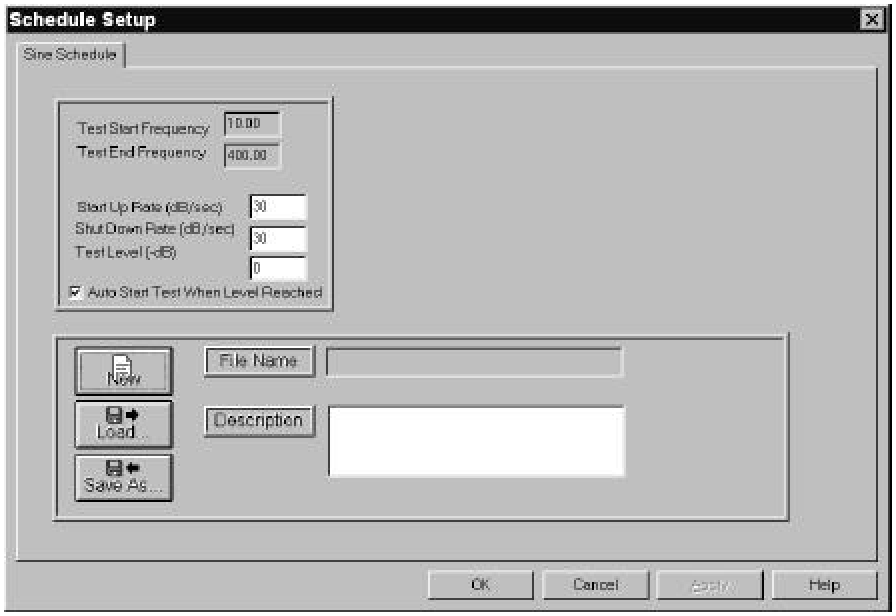


Figure 1-6. Schedule Setup Window

1.5.4.2 Existing Test

Procedural Steps

1. On the PUMA BASIC Local Screen, click **FILE**⇨**NEW**. The **New** Dialog Box appears. See Figure 1-7.
2. Click **SINE**⇨<OK>.
3. Click **FILE**⇨**OPEN**.
4. Select appropriate drive and file
5. Click <Open> on the standard Windows File **Open** Dialog Box.

The test is ready to run.

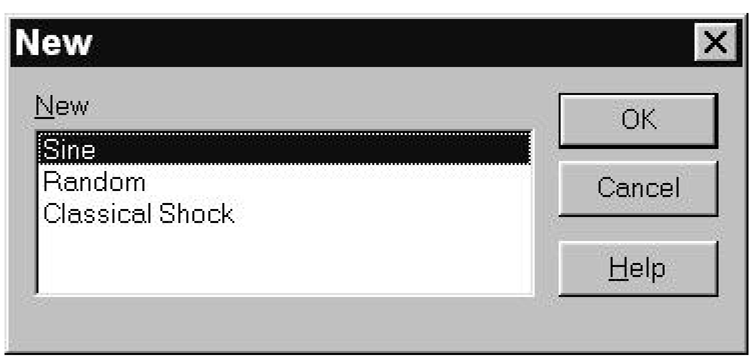


Figure 1-7. NEW Dialog Box

1.6 Arranging Screen Components

During the test the screen can become cluttered and difficult to manage. Some components can be minimized; some have to be sized while others can only be open or closed.

The Puma Basic Local Window components can be minimized, closed or hidden, but the window itself cannot be minimized during a test. Instead, it can be sized to help with the presentation and to keep it from interfering with the procedure. With all the components minimized the PUMA BASIC Local Window would appear as shown in Figure 1-8. Between or before tests begin the PUMA BASIC Local Window can be minimized like any other.

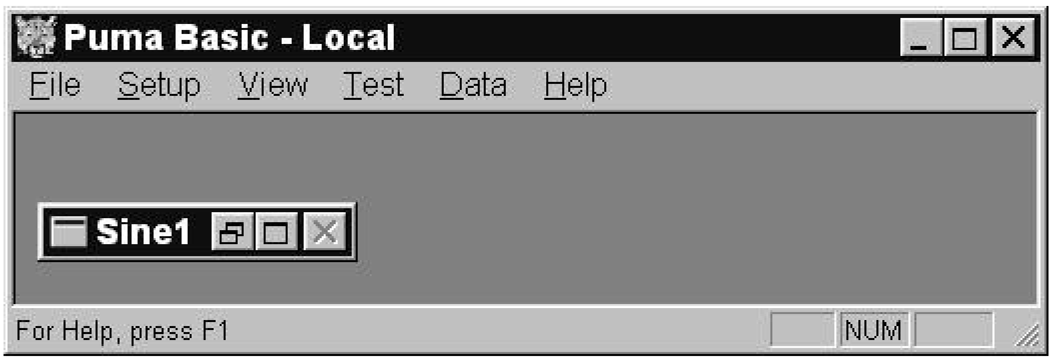


Figure 1- 8. PUMA BASIC Local Window With Everything Minimized

1.7 Common Areas of Host Dialogs

The layout of screens, windows and dialog boxes sometimes differs from one menu option to another. Even though the command buttons may be in a different position, they will work the same from one menu option or function to another.

1.7.1 File Selection Box

Throughout PUMA BASIC there is a need to save the parameters of tests, load those same parameters for another test or just start on something brand new. The File Selection Box (FSB) is shown in the lower portion of Figure 1-4, and the lower right hand corner of Figure 1-5. It is a common Windows tool and is used throughout the PUMA BASIC platform though sometimes the format is somewhat different. The components of the FSB are outlined below for the primary setup areas of Channel Definition, Profile Settings and Schedule Setup.

1.7.1.1 New Selection Command Button

- Channel Definition — The path / name of the currently open file is deleted from the File Name text box. It does not delete the numbers from any of the columns. It is **not** active during a test.

❑	Profile Settings	Clears all columns of data. It is **not** active during a test.
❑	Schedule Setup	Clears all columns of data. The path / name of the currently open file is deleted from the File Name text box. It is **not** active during a test.

1.7.1.2 Load File Command Button

This button reacts the same way in all three parameter input areas. The **Open** Dialog Box is displayed for the user to choose a file to be loaded. All three areas are **active** during a test.

1.7.1.3 Save As Command Button

This button also reacts the same way in all three parameter input areas. The **Save As** Dialog Box is displayed for the user to save a file. All three areas are **not** active during a test.

1.7.1.4 OK Command Button

This button accepts any changes made, applies them and closes the open dialog box.

1.7.1.5 Cancel Command Button

This button closes the open dialog box without applying any changes that may have been made.

1.7.1.6 Apply Command Button

This button applies any changes that have been made and keeps the dialog box open.

1.7.1.7 Help Command Button

This button launches the on-line help. If a dialog box is open it must first be closed to launch the help menus.

Chapter 2 - Test Concepts and Definitions

2.1 Introduction

This section discusses closed loop swept sine vibration testing, and introduces the terminology used to describe the swept sine control capabilities provided in the Sine program.

The Sine program for the VCS provides a digital, closed-loop, multi-channel control capability for performing a variety of swept sine vibration tests. The program generates a sinusoidal digital signal of changing frequency that is converted to an analog signal. This signal is passed through a digital attenuator and sent to the drive amplifier of an external load (shaker and device under test). The system then accepts analog response signals from the external load accelerometer amplifiers, digitizes these analog signals, and converts them to a single acceleration level that characterizes the behavior of the external load at the current drive signal frequency. The drive signal frequency and amplitude are continuously controlled so that the response signals produce acceleration levels that match the reference spectrum you specify.

The reference spectrum and associated parameters describe how the frequency and amplitude of the drive signal vary with time. Frequency control is specified by the start and end frequencies for the drive signal, how the frequency sweeps between these limits, and how many times the drive spectrum sweeps between the limiting frequencies. Amplitude control is specified by the shape of the reference spectrum, which indicates desired amplitude versus frequency relationship.

2.2 Swept Sine Testing

During manufacturing, shipment, and use, all products encounter stress. Swept sine tests are performed on both prototype and production line products to ensure that the product will survive actual production, shipping, and in-use conditions.

Product vibration testing is conducted by subjecting the product to a stress - mechanical vibration. This mechanical vibration can identify design weakness, and allow early correction of design problems.

Sine vibration environments contain only a discrete frequency for a sine wave that changes frequency over time. A sine vibration environment is used to locate resonance or bending modes in test articles.The Vibration Controller can generate a wide range of sine vibration environments to satisfy any commercial, industrial, or military test requirements. These tests subject the test unit to single-frequency excitation over a specified frequency range (swept sine) or at a fixed frequency if the sweep is halted (non sweeping sine). The test setup parameters are used to define a Sine test. These parameters include the frequency range to be covered by the sweeping sine wave, the sweep rate, the total test time in terms of absolute time or the number of sweeps, and a reference spectrum that specifies the desired amplitude versus frequency relationship over the sweep range. During a test, you can halt the sweep (so that the test unit is excited at a constant frequency), resume the sweep in the same direction or in the reverse direction, and vary the sweep rate.

Real-world vibration environments typically exhibit multiple frequencies or frequencies covering an entire range. Nevertheless, single-frequency sine testing provides a means of:

- Investigating the dynamic properties of a unit
- Studying the effects of the excitation frequencies on the unit's performance characteristics
- Determining the resonant or critical frequencies where the unit's performance is degraded or damage occurs

Using these sine test capabilities, you can conduct a modal survey of the resonance's of the unit.

2.3 The Sine Control Loop

Figure 2-1 identifies the major processes that take place in the Sine control loop.

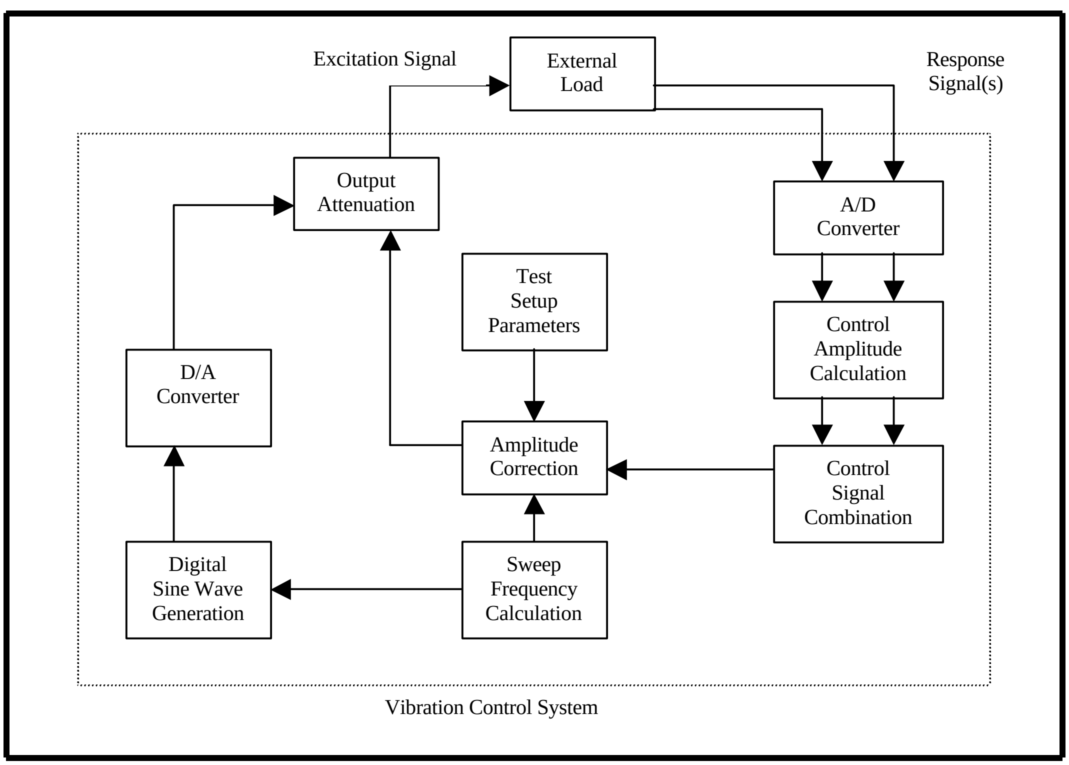


Figure 2-1. Overview of Sine Control Loop

The Sine Control Loop consists of the Vibration Controller and an external load.

The external load consists of: the shaker, power amplifier, fixture, unit being tested, accelerometer(s), and the charge amplifier(s) that produce the vibration response signal(s). The VCS initiates and terminates the test, generates the excitation signal, and monitors all test operations.

The Sine test to be performed is completely defined by the test setup parameters you enter before running the test. The setup parameters include the sweep limits, the sweep rate, and the reference spectrum. The reference spectrum establishes a frequency versus amplitude relationship for the test. For each frequency in the test range, the reference spectrum specifies the amplitude of the sinusoidal vibration for each frequency in the test range to which the unit will be subjected.

Each response signal from the external load is converted from analog to digital form by an A/D converter. An amplitude value is calculated from the digitized data received on the input channels. The amplitude values from the individual channels are then combined to form a single value that represents the composite vibration amplitude of the unit being tested.

The Sine program now computes the current excitation frequency (based on the minimum and maximum test frequencies, the frequency of the last loop, the current time, and the sweep rate). The computed frequency value is used in two ways. First, a digital sine wave with the computed frequency is generated and is converted from digital to analog form. Second, the user selected vibration amplitude at the current frequency is computed from the reference spectrum and compared with the actual vibration amplitude of the unit under test. Any difference in amplitude between the measured signal and the user-selected reference represents an amplitude error. This error is used to calculate an amplitude correction value. This value is used to change the amplitude of the new analog sine wave. To complete the loop, the corrected sine signal, with updated frequency and amplitude, is then sent from the Vibration Controller to the external load. The loop is repeated for the duration of the sine test, with sweeping frequency and constantly corrected amplitude.

A detailed description follows.

2.3.1 External Load

The external load includes the shaker apparatus and the unit under test. A single output channel from the system carries the drive signal to the shaker power amplifier to excite the load. Up to sixteen accelerometers can be attached to the load. The output signals from the accelerometer amplifiers provide the input signals to the system.

2.3.2 A/D Converter(s)

Each A/D Converter (one per input channel) is continuously sampling the input and supplying the input measurement process with data. You select the input measurement process, RMS or Tracking Filter. The units of the data are volts. You specify certain input channels to be control channels, limit channels, or auxiliary channels. Control channels affect the drive signal amplitude and thus control the external load. Limit channels limit the drive signal amplitude for load safety considerations. Auxiliary channels allow display of additional individual input channels.

Data is sampled simultaneously on each active channel at a constant sampling rate of 51,000 samples per second.

2.3.3 RMS Processing

The data supplied by the A/D converter is squared and sent through a low pass filter by the DFE processor to give a continuous RMS calculation of the input signal amplitude. This continuous RMS calculation will result in an estimate of the input signal amplitude that includes the energy of the fundamental frequency and all associated harmonics up to the maximum test frequency.

NOTE: The DFE operations are completed in parallel for each channel. This technique improves the control loop speed.

The analog input voltage (Vi) for each channel is assumed to be a sine wave with constant amplitude A, at a frequency ωt. The term for the input voltage can be stated as:

$$A \sin wt$$

The A/D converter supplies the DFE Digital Signal Processor (DSP) with a digital value corresponding to the instantaneous input voltage. The DSP then mathematically process the values as follows:

By squaring the input voltage, we obtain:

$$A^2 \sin wt$$

By using the trigonometric power relationship for $\sin^2 wt$, we obtain:

$$\frac{A^2}{2}(1 - \cos 2wt)$$

By simplifying terms, we obtain:

$$\frac{A^2}{2} - \frac{A^2}{2}\cos 2wt$$

A digital low pass filter is then used to remove the double frequency term, $\frac{A^2}{2}\cos wt$

leaving a DC value, $\frac{A^2}{2}$, which is proportional to the original amplitude A.

To create the RMS value, the square root operation and averaging is completed in the MDSP controller processing.

2.3.4 Tracking Filter Processing

The tracking filter uses a 0 Hz intermediate frequency Co-Quad detector.

The DFE microprocessor generates a digital sine and cosine waveform at the same frequency and phase as the DBE microprocessor.

The data supplied by the A/D converter is multiplied by both the sine and cosine to produce a complex heterodyne of the input signal at 0 Hz (DC) and at twice the frequency of interest.

The complex result is sent through a low pass filter to remove the doubled frequency terms (ripple), averaged, and then the magnitude and phase are computed. The magnitude is used for control and the phase is used for channel-to-channel transfer function calculations.

NOTE: The DFE operations are completed in parallel for each channel. This technique improves the control loop speed. The analog input voltage (V_i) for each channel is assumed to be a sine (or cosine) waveform with constant amplitude A, at a frequency ωt, and with phase difference, è, from the drive.

The term for the input voltage can be stated as:

$$A\cos(wt - f)$$

The imaginary part of the input voltage ($V_{imag\ i}$) is multiplied by the sine of the drive. This value is given by:

$$A\cos(wt - f)\sin wt$$

By using the trigonometric angle sum, double-angle and power relations we obtain:

$$\frac{A}{2}(1-\cos 2wt)\sin f + \frac{A}{2}\sin 2wt\cos f$$

By simplifying terms we obtain:

$$\frac{A}{2}\sin f - \frac{A}{2}\cos 2wt\sin f + \frac{A}{2}\sin 2wt\cos f$$

A digital low pass filter is used to remove the double frequency terms, leaving the imaginary part of the input voltage, ($V_{imag\ i}$), in terms of the phase shift, f . This value is given by:

$$\frac{A}{2}\sin f$$

The real part of the input voltage ($V_{real\ i}$) is multiplied by the cosine of the drive.

This value is given by:

$$A\cos(wt - f)\cos wt$$

By using the trigonometric angle sum, double-angle and power relations we obtain:

$$\frac{A}{2}(1+\cos 2wt)\cos f + \frac{A}{2}\sin 2wt\sin f$$

By simplifying terms we obtain:

$$\frac{A}{2}\cos f + \frac{A}{2}\cos 2wt \cos f \; \frac{A}{2}\sin 2wt \sin f$$

A digital low pass filter is used to remove the double frequency terms, leaving the real part of the input voltage, ($V_{\text{real i}}$), in terms of the phase shift, f . This value is given by:

$$\frac{A}{2}\cos f$$

By combining the real and imaginary parts of the input voltage, the RMS is calculated by:

$$V_{RMS = \left(\sqrt{\left(V_{reali}\right)^2 + \left(V_{imagi}\right)^2}\right) * \left(\sqrt{2}\right)}$$

By combining the real and imaginary parts of the input voltage, the phase shift is calculated by:

$$f = \frac{180}{2p}\tan^{-1}\left(\frac{V_{imagi}}{V_{reali}}\right)$$

The term $\cos(wt)$ represents the output signal from the DBE microprocessor. It is also the imaginary part of the carrier signal used by the DFE microprocessor in the heterodyne process. The presence of the phase term f in the above equations represents the phase shift in the input signal due to smoothing filters in the DBE, the anti-aliasing filter in the DFE, DBE output signal attenuation dynamics, as well as the dynamics of the device under test. The phase shift due to the DBE and DFE filters are known quantities, which are removed from the phase result above.

2.3.5 Control Signal Combination

Each of the single Mean Square values is then converted to an acceleration level (in g's) using a specified accelerometer sensitivity (in millivolts per g) for that channel.

The per channel acceleration levels for each control channel are combined to form a composite control acceleration level A. The following control strategies are selectable for combining the per channel levels:

- The root mean square average: $A = \sqrt{\left(\frac{1}{m}\right)\sum_{i=1}^{m}\left(a_i\right)^2}$
- The arithmetic average: $A = \left(\frac{1}{m}\right)\sum_{i=1}^{m}\left(a_i\right)^2$
- The maximum per channel level: $A = \left(a_i\right)\max$

- The minimum per channel level: $A = (a_i)\min$

The composite level is used to update the drive signal amplitude as long as acceleration control is in effect.

2.3.6 Control Spectrum Correction

The composite acceleration level derived from the control signal inputs is compared to the reference level for the current sweep frequency. An error value for this frequency is computed as the ratio of the composite control spectrum level over the reference spectrum level.

2.3.7 Test Setup Parameters

As shown by Figure 3-1, the test setup parameters are used for Control Spectrum comparison and correction before attenuation is calculated.

2.3.8 Sweep Frequency

The program determines the frequency values for the current loop in the frequency sweep by using the sweep start and end frequencies, the sweep rate, and the last frequency output in the previous loop.

2.3.9 Digital Sine Wave Generation

The DBE and DFE microprocessor use a double precision integrated phase sine generation algorithm. This algorithm re-computes the sine phase on a sample-by-sample basis. The result is a smooth sine output signal with an accurate drive frequency sweep rate and low harmonic distortion.

2.3.10 D/A Converter

The digital drive signal is converted to analog form and has a range of+10 to -10 volts.

2.3.11 Attenuation Calculation

The attenuator setting to be applied to the attenuated drive signal is calculated, based on the either the control error or the largest limit channel error. A description of the steps taken to determine the attenuator setting follows.

All input channels designated as control channels are combined using the strategy you define (Avg, Max, or Min). The resulting control signal is compared to the reference amplitude for the current drive frequency, and a control error is calculated.

Each limit channel input signal is compared to its defined limit, which you supply, and an error for each channel is calculated. If any of the limit channel signals exceed their limits, the largest limit channel error is selected as the limit error for the loop.

If there was no limit channel error then the control error is used as the loop error otherwise the limit channel error is used as the loop error.

The loop error is now used for the attenuation calculation. There is one more factor used in the attenuation calculation. That factor is the compression. This quantity varies the speed with which the control loop adapts to changes in response by the external load. It thus allows a direct choice between control speed and control stability of the loop. If a compression of *k* percent has been specified, then the fraction of the loop error value that is applied to the attenuation calculation is *k/lOO*.

There are three safety checks made during attenuation calculation. First, if any of the control channel signals do not exceed a threshold defined during loop check, a control signal loss is recognized, and the test is aborted. The only exception to this rule is if the previous control loop attenuation calculation used a limit channel error. In that case, if the input signal of the limit channel in control does not exceed the threshold, a control signal loss is recognized, and the test is aborted. Second, if the input signal of any channel defined as an abort channel exceeds its limit, the test is aborted. Third, if the new attenuation calculation result exceeds a drive limit you define, then the attenuation limit is adjusted to match the drive limit and an alarm is given.

2.3.12 Output Attenuation

The DBE microprocessor produces a continuously sweeping sine waveform at a constant full-scale value of ± 10 volts. This signal is kept at the proper level by using the latest calculated attenuation value for the DBE analog attenuator.

2.3.13 Smoothing Filter

The shape of the analog drive frame produced by the D/A converter is not smooth but consists of a number of small steps. The smoothing filter operates on the signal to smooth these steps and produce a clean sinusoidal shape. The output of the smoothing filter is the unattenuated drive signal, available at the UNATT connector located at the rear of the system.

2.4 Channel and Spectrum Definitions

The various types of channels, signals, spectra, and functions used in the Sine program are identified by an X in Table 2-1 and are defined as follows:

- The term **channel** is used in regard to the hardware involved with the input or output of data.
- **A signal** refers to the time-domain data, either analog or digital, that is input or output on a channel.
- **A spectrum** is a digital, frequency-dependent quantity that is obtained from an input signal or is used to produce an output signal.
- **A function** is a frequency-dependent quantity that is computed from two or more spectra.

The spectra occurring in the Sine program are produced in real time on a point-by-point basis during a test or analysis run. The reference spectrum is a special case. You define the spectrum as part of the setup operation; it is not derived from real time data.

All data generated by accelerometers attached to the external load and connected to the system's analog-to-digital (A/D) converter constitute the input signals. The A/D channels through which the data enters the system are the input channels. Input signals have units of volts when they enter the system, and are then converted by the program to acceleration levels in units of g's (if appropriate), using accelerometer sensitivities supplied as setup parameters.

Table 2-1. Channels, Signals, Spectra, and Functions

Type	Channel/ Signal	Real-time Spectrum	Defined Spectrum	Functions (Computed Spectrum)
Reference			X	
Abort	X	X		
Control	X			X
Limit	X	X		
Error				X
Drive	X	X		
Auxiliary	X	X		
H(f)				X

2.4.1 Reference

The information for the Reference Spectrum is too large to be described here. It will be described following a description of the other types.

2.4.2 Abort

You specify one or more input channels as abort channels. The input data on these channels are the abort signals.

Abort Channels are relevant only for test runs. You supply a threshold, or abort value (in Volts or g's), as a setup parameter. For each loop, an abort channel error is calculated as the ratio between the abort channel signal and the abort value. If the abort channel signal is above the abort value (the error is greater than 1.0), the test is shutdown. When an abort channel stops a test, a message is printed in the Status Panel Message pane showing the channel, input level, and drive frequency of the event.

The abort channels thus serve to safeguard the test specimen by stopping a test if an excessive response signal level from some point on the unit should occur.

An abort channel can be individually displayed during a test with the display's Auxiliary spectrum selection command.

2.4.3 Control

A separate control amplitude is calculated once each control loop. This calculation is the composite of all input channels specified as a control channel in the active setup parameters. This spectrum is selectable as the "control" spectrum on the spectrum display.

NOTE: (1) Each channel defined as a control channel is also an auxiliary channel. (2) A separate auxiliary spectrum is calculated from each control channel and may be independently displayed.

The control signals are those input signals you selected to control the external load and therefore affect the drive signal level. You can choose from one to sixteen input signals to be control channels. The A/D channels that carry the selected control signals are designated the control channels. A control channel cannot also be defined as a limit or abort channel.

During each loop, data is received on each control channel, digitized, and the RMS of the data is calculated on a point-by-point basis. The RMS calculation process used is either a Low Pass RMS detector or a Band Pass Tracking Filter, depending on the Measurement process you select. The data is then converted to peak g's (acceleration).

The program computes the composite control amplitude from the acceleration levels of each individual control amplitude. It is this composite amplitude that is compared to the reference amplitude to compute the control error. The composite control spectrum is selectable for display via the Control menu parameter. Individual control channel spectra may be viewed separately by using the display's 'Auxiliary' menu parameter. You can choose any of the following strategies to form the composite amplitude from each individual control amplitude: the minimum acceleration level, the maximum acceleration level, or the arithmetic average of acceleration levels.

2.4.4 Limit

You may specify one or more input channels as limit channels. The input data on these channels are the Limit Response signals. Limit Response channels are relevant only for test runs. You must specify a Limit Profile as a setup parameter. A limit channel error is calculated for each loop as the ratio between the limit channel response and the limit profile.

If the limit channel response is above the limit profile (the error is greater than 1.0), that limit error is used to correct the drive amplitude for the next control loop. If more than one limit channel error signal is greater than 1.0, then the largest limit channel error is selected for correcting the next control loop drive amplitude. When a limit channel takes control of the drive amplitude, a message is printed in the Status Panel Message pane showing the channel, input level, and drive frequency.

The Limit channels are used to safeguard the test specimen by overriding the effect of the control channels if an excessive response signal level from some point on the unit should occur.

2.4.5 Error

The error amplitude computed for each loop of a test is either the control error or the largest limit channel error if a limit channel is in control. The error value is used to update the amplitude of the drive so as to minimize the loop error.

2.4.6 Drive

The drive spectrum is the sine wave data based on the reference spectrum and the error spectrum. The drive signal (or output signal) is the analog sine wave signal produced by the D/A converter and transmitted from the system to the external load during a test. The system output channel over which the drive signal is transmitted is the drive channel.

The sweep and loop control parameters supplied as setup parameters specify the frequency content of the drive signal. The reference spectrum, as modified by the error spectrum, controls the drive signal amplitude. The drive signal excites the device under test in such a fashion that the composite control spectrum matches the reference spectrum.

2.4.7 Auxiliary

You specie one or more input channels as auxiliary channels. The data input on these channels are the auxiliary signals. The series of these acceleration values for each auxiliary channel is the auxiliary spectrum for that channel.

If you select the Tracking Filter measurement process in the Control Parameter window, then a phase spectrum for each auxiliary channel will be computed from the input data. The auxiliary channels are used for display purposes.

2.4.8 H(f)

You can specify pairs of input channels in the H(f) Table.

NOTE: When you define channel pairs in the H(f) Table, each of the channel numbers in the channel pair *must* be defined as a Control or Auxiliary channel in the Channel Table.

The quantities computed by the program depend on the selection made for the Measurement Process setup parameter. If you select RMS, the program computes the transmissibility for each channel pair. The transmissibility is the ratio of channel spectrum magnitudes, and is a non-complex function with magnitude only and no phase; in this case the H(f) phase display is blank.

If you select Tracking Filters as the Measurement Process, the program computes a true H(f) function with magnitude and phase for each channel pair. The Tracking Filter processing is not available for the Analysis function. If you specie channel zero for either channel of a channel pair, the program will compute transmissibility for that channel pair, regardless of the measurement process you select.

2.5 Reference Spectrum

The Reference Spectrum describes the way the amplitude of the sine wave drive signal varies with frequency over the range of the frequency sweep. You can define the reference spectrum through a table in the setup parameters. During a test run, the composite control spectrum value for each loop is compared to the amplitude value of the reference spectrum for the current sweep frequency. The resulting error spectrum value updates the drive signal for the next loop. By this means, the load is controlled to the reference spectrum throughout the test.

2.5.1 Reference Segments

The reference spectrum describes acceleration versus frequency relationship that is the selected excitation for the device under test during a test run of the Sine program. A reference spectrum is established by a number of program parameters that form part of the parameter set entered via the program's setup function. It is defined as a series of up to 100 segments, where a segment of the reference spectrum establishes the acceleration versus frequency relation over a specific portion of the sweep frequency range. Each segment is defined by supplying up to five parameters: type, value, ending frequency, alarm limits, and abort limits. These parameters are described individually in the following paragraphs. **Segment Type-**

The acceleration versus frequency dependence for a segment may be selected to be any of the following types:

Constant Displacement

This type specifies a constant peak-to-peak displacement of the test specimen over all frequencies in the segment.

For a constant sinusoidal displacement:

$$s = K\sin\left(2p\ ft\right) = S_0$$

the equivalent acceleration is proportional to *ft* and to the constant displacement, or:

$$a = Kf^2 S_0$$

If this curve is plotted on a scale of linear acceleration versus linear frequency, it forms a parabola that passes through the origin (since zero displacement at zero frequency yields zero acceleration) and is convex upwards. The curvature of the parabola depends on the constant displacement S_0.

Constant Velocity

This type specifies a constant zero-to-peak velocity for the test specimen for all frequencies in the segment. For a constant sinusoidal velocity $v = K\sin\left(2p\ ft\right) = V_0$

the equivalent acceleration is proportional to f and to the constant velocity, or

$$a = KfV_0$$

If this relationship is plotted on a scale of linear acceleration versus linear frequency, it forms a straight line that passes through the origin (because zero velocity at zero frequency produces zero acceleration). The slope of the line depends on the constant velocity V_0.

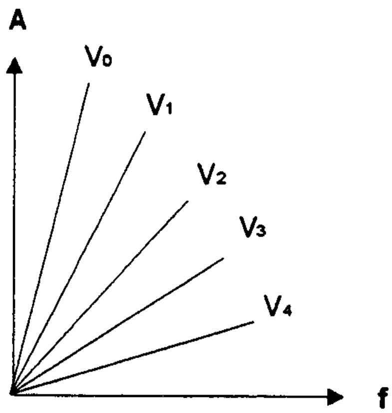
Constant Acceleration

This type specifies that the test specimen shall be subjected to a constant zero-to-peak acceleration A_0 for all frequencies in the segment. If this relationship is plotted on a linear acceleration versus frequency scale, it results in a horizontal line with height given by the constant acceleration A_0.

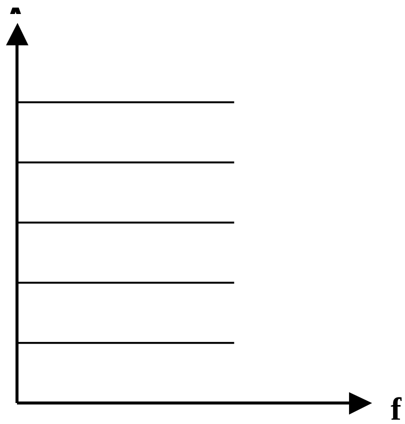
Straight Line Acceleration Versus Frequency

Specifies that the acceleration value at the end of the previous segment shall be connected by a straight line to the acceleration value for this segment at the end frequency of this segment. Two types are supported: both the acceleration and frequency are linear, or both the acceleration and frequency are logarithmic.

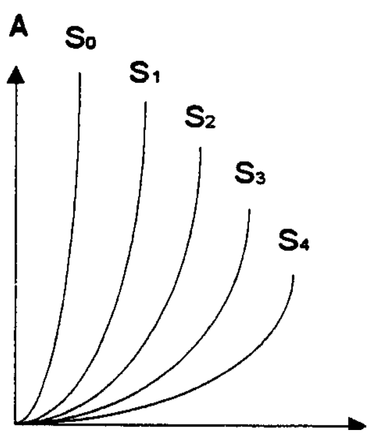
Figure 2-2 shows the acceleration/frequency relationships resulting from each of the segment types on a scale of linear acceleration versus linear frequency, except the straight line acceleration versus frequency, which could also be log acceleration versus log frequency.



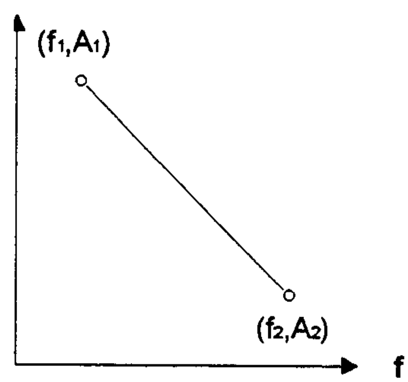
Acceleration resulting from constant velocity Vi



Constant acceleration A



Acceleration Resulting from constant displacements



Straight-line acceleration versus frequency (axes can be either

Figure 2-2. Acceleration/Frequency Relationships for Reference Spectrum Segment Types

Segment Value

This quantity gives an amplitude value for the segment. Its interpretation by the program depends on the segment type selected as follows:

- Value = displacement if the segment type is constant displacement.
- Value = velocity, if the segment type is constant velocity.
- Value = acceleration, if the segment type is constant acceleration or straight-line acceleration versus frequency.

Ending Frequency

Specifies the upper frequency limit of the segment. The segment lower frequency limit is fixed either by the start sweep frequency (if this is the first segment of the reference spectrum) or by the upper frequency of the previous segment (if this is the second or a subsequent segment).

An important option is available to you in specifying the upper frequency. That is, if the special value of O (zero) is entered for the frequency, the program computes a crossover frequency that marks the end of this segment and the beginning of the next segment.

Alarm Limits

These limits define a tolerance band in dB above and dB below the reference spectrum level for this segment. If the level of the composite control spectrum exceeds this limit at any frequency in the segment, the program sounds an alarm to alert you of the condition.

Abort Limits

The Abort Limits define a tolerance band in dB above and below the reference spectrum that is wider than and contains the alarm tolerance band. If the level of the composite control spectrum exceeds this outer abort tolerance for 20 successive loops, and if the mode control menu parameter is set to Automatic, the program automatically aborts the test.

2.5.2 Continuity at Segment Boundaries

Each of the segments of a reference spectrum is defined separately. The only inter segment dependence is that a segment's upper frequency becomes the lower frequency for the next segment. The program allows definition of a reference spectrum with discontinuities in the acceleration level from one segment to the next. To control and minimize the occurrence of test abort conditions you should avoid discontinuities; or if they exist, keep the magnitude of the discontinuities small, the abort tolerance bands wide for the segments on each side of a discontinuity, or operate the system in Manual mode (Aborts are disabled).

A Box Tolerance feature is also available to make it easier to specify suitable tolerance bands near a discontinuity.

Take care in defining the reference spectrum if you wish to maintain continuity of acceleration levels at the boundaries of adjacent segments. In particular, when specifying segments having constant displacement or constant velocity, it is difficult to determine exactly what the equivalent acceleration level will be at either the lower or upper segment boundary. Use the crossover calculation feature of this program to help you.

Take care in defining the reference spectrum if you wish to maintain continuity of acceleration levels at the boundaries of adjacent segments. In particular, when specifying segments having constant displacement or constant velocity, it is difficult

to determine exactly what the equivalent acceleration level will be at either the lower or upper segment boundary. Use the crossover calculation feature of this program to help you.

2.6 Safety Features

Protection of the external load is of the highest importance. The Sine control program contains a number of safeguards for this purpose; designed to ensure that no abrupt change or out-of-tolerance condition in the drive signal level occurs that might damage the test specimen or actuator equipment. If during a test any of the safety features are executed, the test aborts and shuts down (see Test Shutdown Time in this section). A list of safety features and the frequency with which each feature is monitored is given below in Table 2-2.

Table 2-2. Monitoring Frequency of Safety Features

Feature	When Monitored
Attenuated Output Delay	Twice per test
Loop check function	Once per test
Control spectrum alarm and abort limits	Once per loop
Control signal loss	Once per loop
Operator abort	Continuous
Abort Channels	Once per loop
Limit channels	Once per loop
Compression	Once per loop
Alarm and Abort Messages (Audible alarms)	Once per loop
Test startup time	Once per test
Test shutdown time	Once per test
Drive signal limit	Continuous
Test Summary List	Once per test

Each feature is designed to protect the external load under a particular set of circumstances. All features except the user abort are automatic and hence do not add to the user workload. Most of the safety features are monitored at least once per control loop; a minimum loop time is thus advantageous not only because it increases control speed but because it also allows more frequent safety checks.

The safety features minimize any possibility of damage to the unit under test. However, you retain final responsibility for proper preparation and maintenance of the external load and signal connections, appropriate use of the safety features and the selection of associated parameters, and careful selection of all maximum signal levels specified for a test.

2.6.1 Attenuated Output Delay

The attenuated output delay feature allows you to monitor the content of the output signal on the Unattenuated output back panel connection for a specified amount of time (in seconds) before the Sine program begins attenuated output and input channel acquisition. This allows external equipment to monitor the frequency of the output signal for the specified amount of time without an amplitude or frequency change.

The attenuated output delay value is checked before the loop check function, and before test start up. If the delay value is not 0 seconds, a message is printed in the Status Panel Message window staling that the Attenuated output is being delayed the specified number of seconds. A delay of O will not result in a message.

2.6.2 Loop Check Function

The loop check is a continuity test of the control loop, including all connections to the external load. The loop check verifies that all equipment in the control loop is connected and functioning, using very low drive voltage levels. You can specify the frequency of the sine wave drive signal output for the loop check (the loop check frequency) and the maximum drive signal level (the loop check maximum drive) to be used during the loop check.

The loop check function should in all cases be applied to an external load before the load undergoes a full test. If the equipment loop is actually open, then control cannot be achieved and the test specimen could be damaged in an unsuccessful attempt to establish control. On the other extreme, if the power or accelerometer amplifier gain settings are too low the loop may appear open when it is really closed. The loop check presents a means of testing the accelerometer gain settings and the selected loop check maximum drive, to determine that they are appropriate and safe for the external load.

In addition to being an independently executable function, the loop check executes automatically at the beginning of the test function. As a pre-test feature, the loop check serves as a final test for loop continuity.

The loop check function begins with a measurement of the ambient noise present on all active input channels. The ambient noise measurement starts with a measurement of the DC content. Sine will make internal adjustments to null any ambient DC before making a measurement of the AC ambient noise. The ambient noise RMS measurement presented is over the frequency range 0 to 8kHz.

The loop check outputs a very low level drive signal and gradually increases the signal level to the loop check maximum drive value. The loop check ends successfully when one of three conditions has been met:

1. The input signal is within a specified range of the minimum reference spectrum level.
2. The input signal is 3dB above he ambient noise measurement.

3. The input signal is above 10mV RMS.

The Sine program will check all three conditions each test and select the largest value for each channel. The loop check function will display the message:

Loop Check Completed

in the Status Panel Messages pane when a measured signal reaches, or exceeds, the threshold value for that channel.

The loop check reports an open loop failure condition if the drive signal level reaches the specified loop check maximum drive level and no control signal above the threshold value is detected on one or more of the control channels.

When the program has successfully completed a loop check, the drive signal level gradually decreases to zero.

The system will print the system gain after the Loop Check Completed message. System gain is the ratio of the control signal level to the drive signal level in decibels.

2.6.3 Control Spectrum Alarm and Abort Limits

The Tolerance Bands are the areas both above and below the Reference Spectrum. You choose where the Alarm and Abort bands are active. These bands are displayed during a test and data review. When the program achieves control of the external load during a test, there is a close match between the amplitudes of the composite control spectrum and the reference spectrum for the current sweep frequency. Conversely, failure to control results in significant discrepancies between the control and reference spectra amplitudes.

Failure to achieve control or loss of control during a test is often due to an equipment malfunction in the external load or to an extreme non-linearity in the structural response of the test unit. Such a condition poses a potential hazard to the external load.

You can specie alarm limits and abort limits for each frequency segment in the reference spectrum, which the program uses to automatically detect amplitude deviations of the control spectrum from the reference spectrum. For each segment you can select a pair of alarm limits in terms of dB above and dB below the reference spectrum level for the segment. Separately and independently, you can specie a pair of abort limits as dB above and below the reference spectrum.

The only restraint placed on the alarm and abort limit values for a frequency segment is expressed by the following relation:

$$\mathrm{ABORT}_{below} < \mathrm{ALARM}_{below} < \text{ref-spectrum} < \mathrm{ALARM}_{above} < \mathrm{ABORT}_{above}$$

The lower and upper alarm limits define an alarm limit tolerance band surrounding the reference spectrum. Similarly, the lower and upper abort limits define an abort limit tolerance band that surrounds both alarm tolerance band and the reference spectrum. You can select the alarm tolerance band for display on the system monitor.

During each loop when the alarm and abort limits are active, the composite control spectrum is compared to the limits. If the amplitude of the composite control signal falls outside the alarm tolerance band, an audible alarm is sounded to alert you. If the control signal is outside the abort tolerance band, the test aborts.

2.6.4 Control Signal Loss

The loss of a signal from any of the control channels during a test can have serious consequences for the test unit. Such a loss means that information required to update the drive spectrum to maintain or achieve control of the external load is missing, and continued output of a drive signal has an unknown effect on the external load. For this reason detection of a control signal loss condition is extremely important, and is reason for immediate shutdown of the test.

The program uses a measurement of the noise level on each control channel, obtained automatically at the start of a test before a drive signal is output. During the test, the program compares the level of each control signal for the current loop to the signal's noise level.

If the signal level is less than or equal to the noise level, control signal loss is assumed and the program aborts the test and initiates shutdown

If you define any input channels as limit channels and a limit channel takes over control of the drive, the control channels will not be checked for control signal loss. Only the limit channel in control of the test is checked for control signal loss. If the signal level of a limit channel in control of a test is less than or equal to the noise level of that channel, control signal loss is assumed and the program aborts the test.

In some situations, you may have a need to modify the way the Safety Parameters detect a Control Signal Loss (CSL).

The Sine program provides two methods of modifying the CSL detection.

1. You may use the Safety Parameters **Reference CSL Threshold (dB)** to define how large a signal is required before the program will recognize a channel loop as closed, and as a consequence, how low a channel signal can drop before a control signal loss is detected.
2. You may use the Safety Parameters CSL **Count Threshold:** to define how many control loops must detect a control signal loss before the test is shut down.

2.6.5 Operator Abort

The system keyboard has a specially designated ABORT key, and the Control Panel has an ABORT button.

The program continuously monitors the ABORT key and the ABORT button.

When you select **ABORT** from either the keyboard or the Control panel, the program shuts down immediately. This safeguards the external load if a dangerous or abnormal situation occurs during a test.

2.6.6 Abort Channels

Abort channels allow you to stop a test if the input signal of a channel exceeds a defined limit. You enter a Limit Profile for each defined abort channel. If during any loop of a test run the actual data value received on an abort channel exceeds the profile value, the program aborts the test.

This feature prevents the sine test from over-stressing any points on the external load that are connected to abort channels.

2.6.7 Limit Channels

Limit channels allow you to override the normal update of the drive spectrum amplitude by the composite control spectrum. Enter a Limit Profile for each defined limit channel.

If during any loop of a test run the actual data value received on a limit channel exceeds the profile value, the program performs an amplitude update of the drive signal using limit channel data (see Limit in this section) instead of the error spectrum.

This feature prevents the sine test from over-stressing any of the points on the external load that are connected to limit channels.

2.6.8 Compression

The compression is a measure of how much of the error is corrected on each loop. This allows a user to choose between speed and accuracy. A low compression means that the system takes longer to respond to a change in control signal level, but allows a more gradual, smoother change in the drive signal amplitude.

A high compression speed means faster return to the reference spectrum amplitude, but also results in more abrupt changes in the drive amplitude that could cause control instability. The Sine control loop uses the Compression Profile to determine what compression to use during the test sweep. The Sweep/Compression Table is used to define the Compression Profile. You may enter up to 40 segments in each Sweep/Compression Table.

The Compression Profile may be viewed in the Sine Reference Display window. If you need to make adjustments to a selected profile during a test, and save the new profile, the Sine program allows you to override the Compression Profile, then save those changes to a new Sweep/Compression Table.

2.6.9 Alarm and Abort Messages

When parameters are out of assigned limits, the program alerts the user with an audible alarm and prints the alarm condition in the Messages pane. The following conditions will produce alarm or abort messages:

- Loop check function
- Control signal loss
- Operator abort
- Drive signal limit
- Control spectrum alarm and abort limits
- Abort Channels
- Limit channels

2.6.10 Test Startup Time

When a test run begins, the drive signal amplitude increases from 0 volts to the amplitude specified in the reference spectrum for the starting frequency of the run.

You select the rate desired to make this transition in amplitude so as to avoid too rapid a change in the drive signal, based on the nature of the test specimen and the test requirements.

2.6.11 Test Shutdown Time

Test shutdown occurs either normally when a test has completed the specified number of frequency sweeps or as the result of an abort condition, either automatic or operator-initiated.

During test shutdown, the final drive signal continues to be output at the same frequency. The level of the drive signal reduces from its value when shutdown is initiated to a level of O volts.

The test shutdown rate is a selectable test parameter that specifies the rate in dB/sec at which the decrease in signal level to 0 volts takes place. This parameter allows you to make a choice that offers the best protection of the external load.

2.6.12 Drive Signal Limit

You can define a test parameter that specifies the maximum drive signal voltage to be output during a test. When this maximum signal is detected, a warning message is presented on the display and the audible tone is sounded to alert you to the high drive signal condition.

2.6.13 Test Summary List

The Data Review function provides summary documentation about the last test function run, and aids in the correct interpretation of any test abort condition that may have occurred.

The information in the Test Summary includes the test ID and test heading of the setup parameters in effect for the run, indicates whether the run completed normally or was aborted, and gives the number of sweeps completed, the run duration and maximum and average amplitude error values.

2.7 Test Scheduling

Sine capabilities include:

- Performing a single test and then initiating another program function,

  or

- Automatically performing several tests in a specified sequence, without having to start each individual test in the sequence.

The second kind of operation is called test scheduling.

You prepare for test scheduling by defining the desired sequence of tests, then writing it on disk as a test schedule file.

You may then run the test sequence by choosing test scheduling (and not single-test) operation, selecting the test schedule file and reading the schedule into memory, and executing a test function.

2.8 Data Storage and Review

Several kinds of information used in the Sine program can be stored on and retrieved from disk, using various program functions and menus. Stored information includes test setup parameters, the test schedule, spectra computed during a test, and the test summary listing. In the following, we summarize the storage and retrieval of this information.

2.8.1 Test Setup Parameters

The test setup parameters file is a complete set of the parameters required to define a Sine test for storage and retrieval. You may create and save as many setup files, as you need. Each file defines a single test and is identified by a different user selected Test Name. A test setup file also contains settings for spectrum display parameters.

2.8.2 Test Schedule

The test schedule file is a set of Test Names that defines a schedule of tests to be run automatically, and can be stored and retrieved in sequence. You may define as many schedule files, as you need.

2.8.3 Spectral Data

At selected times during a test, you can store on disk, as the spectral data file, the spectra that the Sine program calculates and uses. These spectra represent the test conditions when they were stored.

You may store to the spectral data file during a test, and can display the contents of the file later as an off-line replay of the test.

2.8.4 Test Summary

The test summary contains items of information summarizing the test at the test's end. If a spectrum data file has been created during the test, then the test summary information is automatically stored in that data file.

Chapter 3 - File Menu

3.1 Introduction

The first of the six menu options in the PUMA Local Sine function of the PUMA Vibration Control System (VCS) is the **FILE** Menu option. Refer to the following chapters for other menu options.

3.2 The File Menu

When the user selects **FILE** from the Menu Bar, the menu shown in Figure 3-1 will display. The **FILE** menu option has 16 sub-menus and a seven-file list contained in a seven-section drop-down menu list. The seven-file list allows rapid access to files that have recently been worked with.

3.2.1 File Sub-Menus

The sub-menus (Figure 3-1) of the **FILE** Menu option are outlined below.

3.2.1.1 New Menu Option

When the user selects **NEW**, the **New** Option List Box will display. See Figure 3-2. It offers the choice of three test titles that can be initiated. They are:

- Random
- Sine
- Classical shock

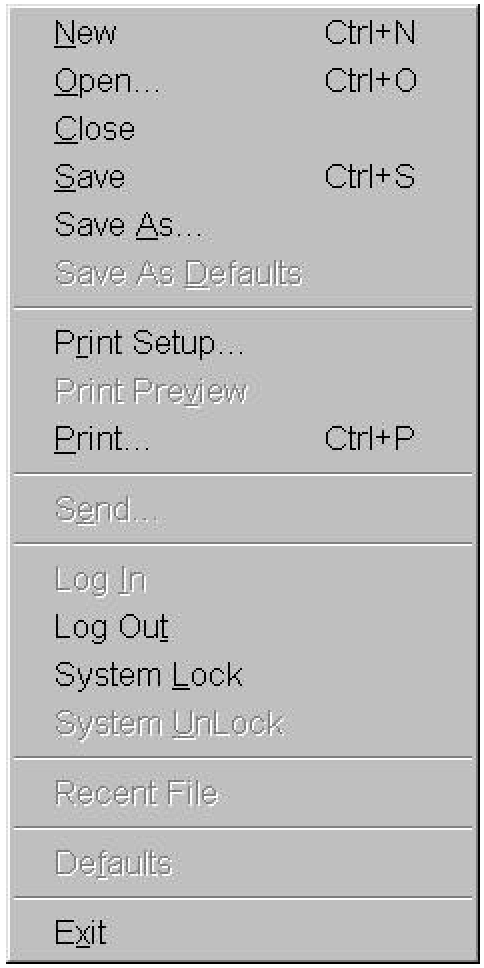


Figure 3-1. File Menu Options

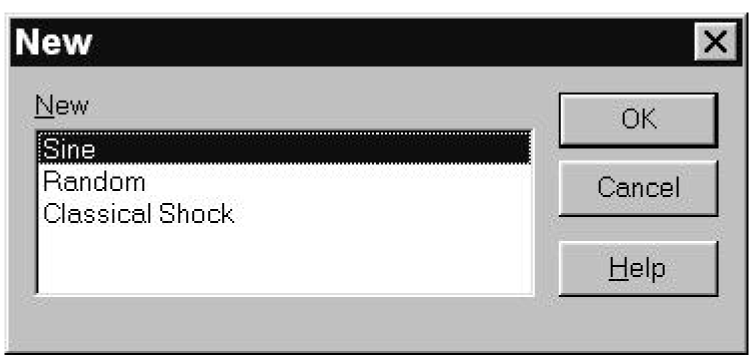


Figure 3-2. New Option List Box

3.2.1.1.1 Random

The Random Test Suite provides digital real-time closed loop shaker control for production testing, design qualification and reliability testing applications. The system allows the definition, simulation and closed loop control for random vibration excitation of a vibration shaker system.

3.2.1.1.2 Sine

The Sine test provides a means of applying continuous swept sine vibration excitation over a wide frequency range. A minimum of two input channels simultaneously monitors multiple accelerometers. A digital to analog converter supports drive output rates to 40kHz.

3.2.1.1.3 Classical Shock

Classical Shock provides a means to apply a pulse of specific magnitude, duration and shape to an object under test. The common pulse types are Half Sine and Trapezoidal.

Clicking on the **NEW** menu option and selecting another test while working on a test will initiate the display of a **SAVE** prompt unless there were no changes made to the test that was downloaded to work on. Please note that there are only four menu options on the PUMA Local window at this time instead of six. The **SETUP** and **TEST** menu options will appear when the new test is launched.

3.2.1.2 Open Menu Option

The **OPEN** menu option directs the user's efforts in a different direction. It displays a standard Windows **Open** (file) Dialog Box. The user can navigate to the desired file and open it.

3.2.1.3 Close Menu Option

When **CLOSE** is clicked a **SAVE** prompt is displayed if the test that is running has had changes made to it. If no changes were made the currently displayed window will close.

3.2.1.4 SAVE Menu Option

When **SAVE** is clicked the standard Windows **Save As** Dialog Box appears. It allows the user to save the currently running test to any file folder desired.

3.2.1.5 Save As Menu Option

The **SAVE AS** menu option also launches the standard Windows **Save As** Dialog Box.

3.2.1.6 Print Setup

PRINT SETUP is a standard Windows command that allows the user to select a printer, the size and source of paper and the orientation of the page. These selections will affect how things are printed when the **Print** option is used.

3.2.1.7 Print

Click on **PRINT** to launch the standard Windows **Print** Dialog Box. From here the user may select a printer, what is to be printed and how many copies are required. The option to print to a file is also available.

3.2.1.8 Send

SEND is a standard Windows command for sending files / tests via e-mail.

3.2.1.9 Log In

The **LOG IN** option is not available when the user is already using PUMA Basic. It becomes available after logging out. See Figure 3-3. When logged in only the LOG OUT option is available. When clicked nothing is shown but the user is logged off and the option is toggled. When LOG IN is clicked the dialog box appears. When filled in and clicked the dialog disappears and the menu option is toggled.

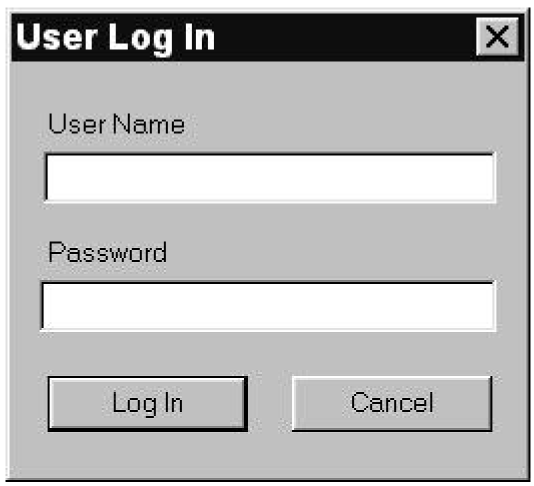


Figure 3-3. Log In Dialog Box

3.2.1.10 Log Out

The **LOG OUT** option is only available when the user is logged in to PUMA Basic. Other options when logged out are shown in Figure 3-4.

3.2.1.11 System Lock/System Unlock

These two features come with the security options. When **SYSTEM LOCK** is selected, the system is locked and that option becomes disabled. The **SYSTEM UNLOCK** option is then enabled. See Figure 3-5. To regain access to the program, the user must select **SYSTEM UNLOCK**. The **User Log In** dialog box will display and allow the user to login. Menu options for the UNLOCK condition are the same as the regular FILE options.

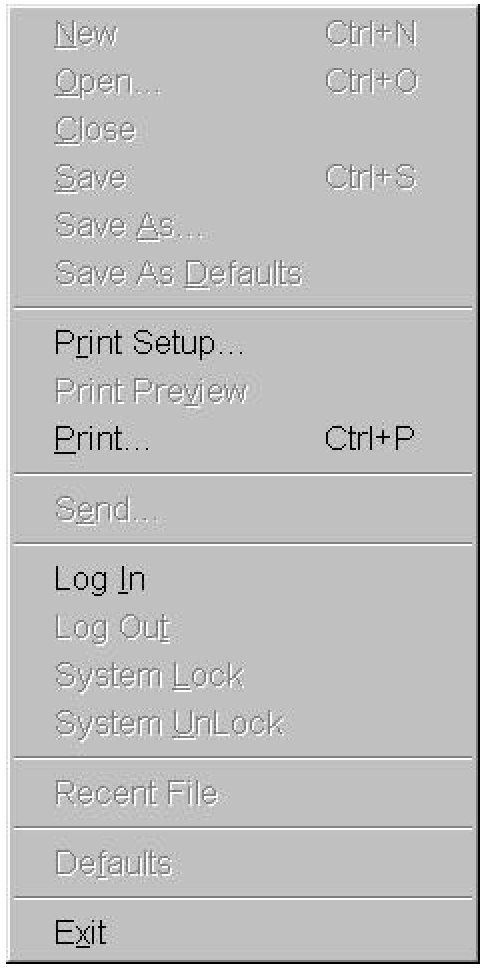


Figure 3-4. Options During Log-Out

3.2.1.12 Recent File List

The recent file list is a standard Windows feature that has been adopted for Puma Basic. It allows the user quick access to the last seven files that have been opened. The path for usage is:

<Start> ⇨ DOCUMENTS ⇨ Applicable File Name

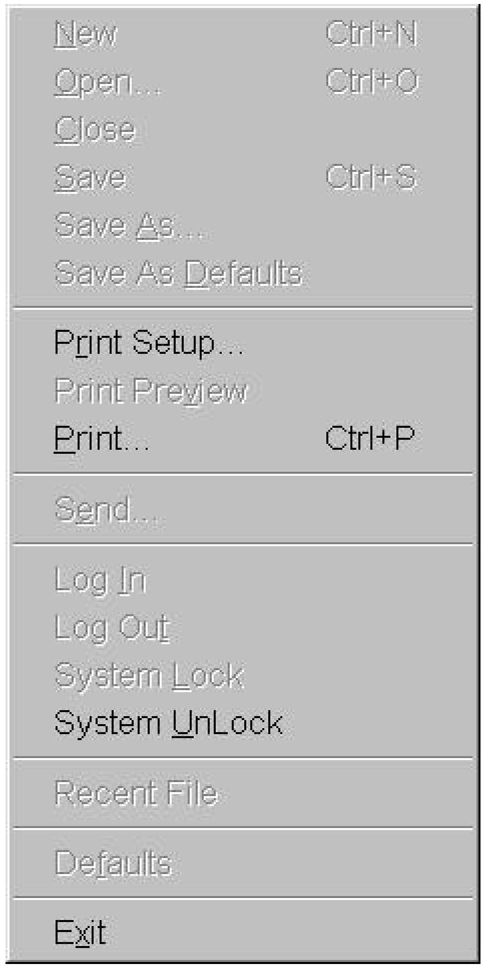


Figure 3-5. FILE Menu Options During System Lockout.

3.2.1.13 Exit

EXIT is a standard Windows command. Clicking on this command will cause the current window to close and the application will terminate.

3.2.2 Menus Available During The Test

During the time frame that a test is running there are only four **FILE** Menu options available for use. They are:

- Print Setup
- Print
- Log Out
- System Lock

Chapter 4 - Setup Menu

4.1 Introduction

The **SETUP** Menu option is the most important menu of the PUMA Basic Sine Function. This is where the user enters information to tell PUMA Basic how to run the tests. The parameters of a new test can be input or a previously generated set of guidelines can be activated from a previously filed test result.

4.2 Sub-Menus

The following paragraphs give information about the seven **SETUP** submenu options available. See Figure 4-1. The user can input information to enable the test results to reach a predetermined goal or manipulate previously used data to produce a different effect.

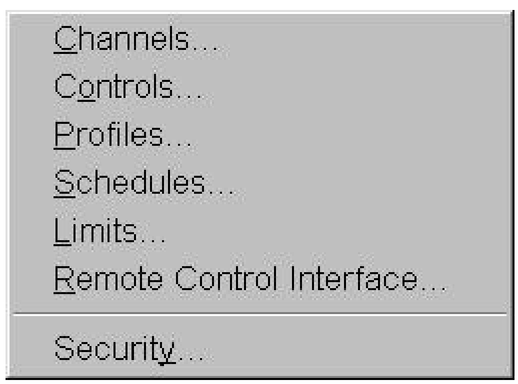


Figure 4-1. Setup Menus

4.2.1 Channels

The **CHANNELS** Menu option produces a **Channel Definition** Window (Figure 4-2). This window allows the user to:

- Print a listing of the Channel Definition settings
- Change any or all of the Channel Definition parameters
- Open a new file
- Load a previously saved test / file
- Use the **Save As** option to name / save a file

- Accept default / user selected file names and initiate selected action
- Cancel selection / window
- Get Help

The first two actions are accomplished in the Channel Definition Window's Table. The remaining actions are accomplished with the File Selection Box (FSB). See Figure 4-3.

The table columns and their functions are discussed in the following paragraphs.

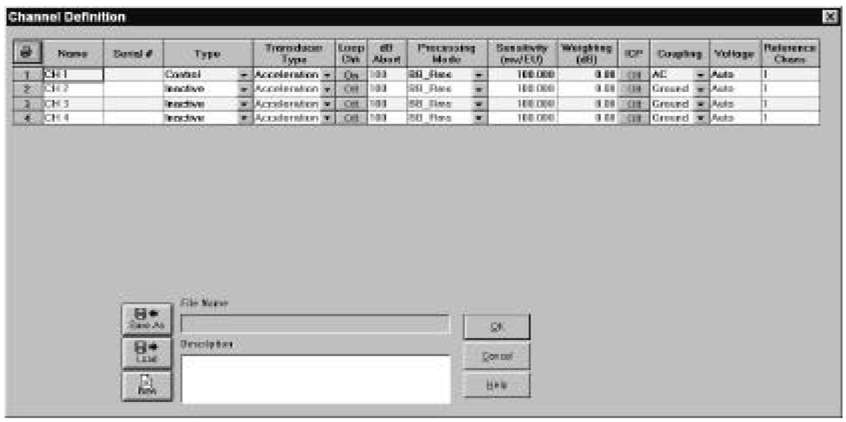


Figure 4-2. Channel Definition Window

4.2.1.1 Channel Definition

Up to four channels can be defined simultaneously. To set the Channel Definition parameters:

Procedural Steps

6. Access the **Channel Definition** Window in accordance with the procedure in paragraph 1.5.
7. Load file or set parameters as required.
8. Save to keep changes (choose **Save As** if information is to be saved independently from the loaded file).

4.2.1.1.1 Column Headings

Print Button / Channel Number Column

Clicking the <Print Button> will cause a printout of the window’s settings. The channel numbers are constant placeholders for the channels.

Name Column

Up to 8 characters can be used to designate a unique name for the channel.

Serial # Column

Up to 10 characters can be used to designate a serial number for the channel.

Type Column

Six choices from drop down list are:

o Abort	Channel is designated as an abort channel
o Control	Channel is designated as control channel and the Loop Check is automatically set to **ON.**
o Inactive	Channel is **OFF** and contains no parameters.
o Limiting	Channel is designated as a limit channel (optional).
o Measurement	A control channel designated as a measurement channel (ie: active but not to be regarded as in the control scheme).
o Reference	Channel is designated as a reference channel.

Transducer Type Column

Three choices from drop down list are:

- Acceleration
- Displacement
- Velocity

Loop Chk Column

The Loop Check option can be either **ON** or **OFF**. If it is on, an open channel "Safety" check is performed before the test is run.

dB Abort Column

This text box is for the decibel level that will cause an abort.

Processing Mode Column

Two choices from drop down list are:

- BB RMS

Sensitivity mv/EU Column

The parameter for the ratio obtained by dividing mili-volts by force in g's. The range is 0.001 to 99,999 mHg or mV/(m/s²)

Weighting (dB) Column

This is the amount of weighting given to the channel for this test. The allowed range is –20 to 6 dB (-3 dB attenuates the signal on the channel by ½).

ICP Column

The ICP function can either be **On** or **Off**. It provides a constant DC current source to power the accelerometers.

Coupling Column

Three choices from drop down list are:

AC– It is used to block the DC component of the signal.

DC– It is used to pass the DC component of the signal.

Ground– It grounds the input channel.

Voltage Column

Any value from 0 to 10 may be entered. Zero is the default for Auto.

Reference Chans Column

This is the decibel level that this channel will use as a reference.

4.2.1.1.2 File Selection Box

Throughout PUMA there is a need to save the parameters of tests, load those same parameters for another test or just start on something brand new. The File Selection Box (FSB) (Figure 4-3) is a common Windows tool and is used throughout the PUMA platform though sometimes the format is somewhat different. The File Selection Box consists of various command buttons and two text boxes. The text boxes are **File Name** and **Description**. The components of the FSB are outlined below.

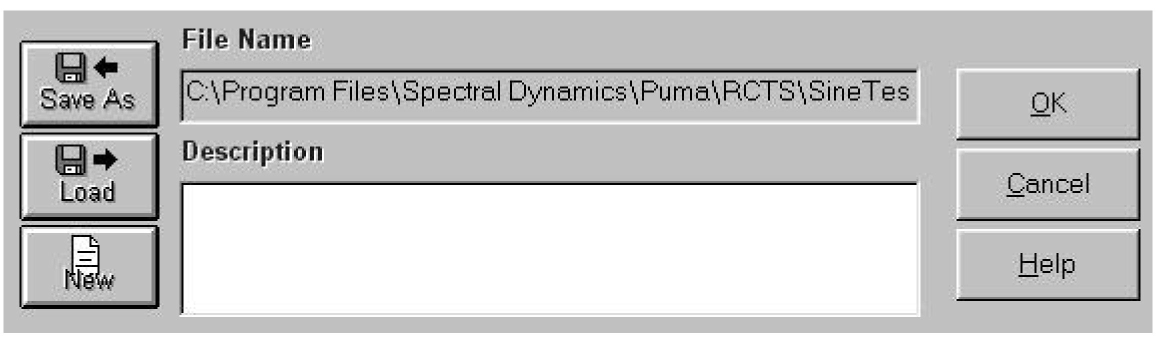


Figure 4-3. A Typical File Selection Box

New Selection Command Button

When initiating a new file the following actions can be observed in the windows listed below.

- Channel Definition — The path / name of the currently open file is deleted from the File Name text box. It does not delete the numbers from any of the columns. It is **not** active during a test.
- Profile Settings — Clears all columns of data. It is **not** active during a test.
- Schedule — Clears all columns of data. The path / name of the currently

Setup open file is deleted from the File Name text box. It is **not** active during a test.

Load File Command Button

This button reacts the same way in all three parameter input areas. The **Open** Dialog Box is displayed for the user to choose a file to be loaded. All three areas are **active** during a test.

Save As Command Button

This button also reacts the same way in all three parameter input areas. The **Save As** Dialog Box is displayed for the user to save a file. All three areas are **not** active during a test.

OK Command Button

This button accepts any changes made, applies them and closes the **Open** Dialog Box.

Cancel Command Button

This button closes the **Open** Dialog Box without applying any changes that may have been made.

Apply Command Button

This button applies any changes that have been made and keeps the dialog box open.

Help Command Button

This button launches the on-line help. If a dialog box is open it must first be closed to launch the help menus.

4.2.2 Controls

The **CONTROLS** Menu option displays the **Test Settings** Window. This window has three tabs. They are:

- Sweep Parameters
- Control Setup
- Data Storage

At the bottom of each tab are four standard Windows Command Buttons. They are:

<*OK*> Command Button

This button accepts any changes made, applies them and closes the open dialog box.

<*CANCEL*> Command Button

This button closes the open dialog box without applying any changes that may have been made.

<*APPLY*> Command Button

This button applies any changes that have been made and keeps the dialog box open.

<*HELP*> Command Button

This button launches the on-line help. If a dialog box is open it must first be closed to launch the help menus.

4.2.2.1 Test Settings

The three **Test Settings** Window Tabs are described below. See Figures 4-4 thru 4-7.

4.2.2.1.1 Sweep Parameters

The ***Sweep Parameters*** Tab (Figures 4-4 and 4-5) has two group box areas; a list box and a text box. The **Duration** Group Box has a list box and four text boxes. The **Duration Type** list box gives the choice of *Time* or *Sweeps*. The text boxes are self-explanatory. The **Clear Sweeps** List Box choices are *Every Sweep* or *Every Other Sweep*.

On the right hand side of the tab is the **Sweep Parameters** Group Box. It consists of four list boxes and five text boxes. The list box options are shown in Table 4-2 and the text box labels are listed in Table 4-3.

Table 4-2. Sweep Parameters Group Box List Boxes

Sweep Mode	**Initial Sweep Direction**	**Sweep Type**	**Multiple Sweep Rate Definition**
Log	*Up*	*Rate*	*100 / 50 / 25*
Linear	*Down*	*Timed*	*Arbitrary*

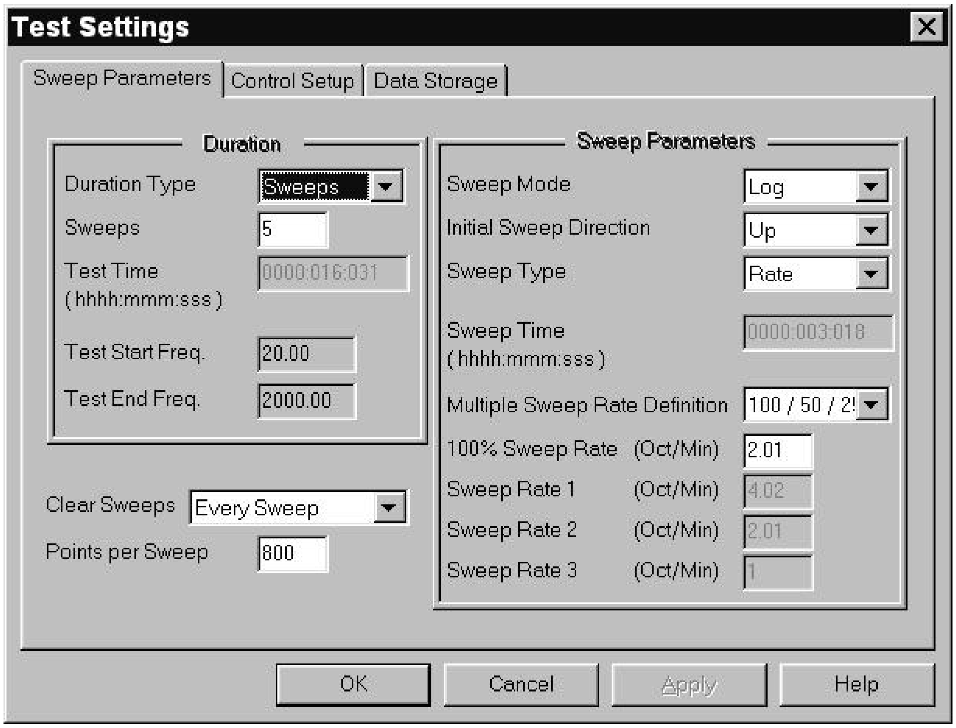


Figure 4-4. Sweep Parameters Tab of Test Settings Window Set for Sweeps

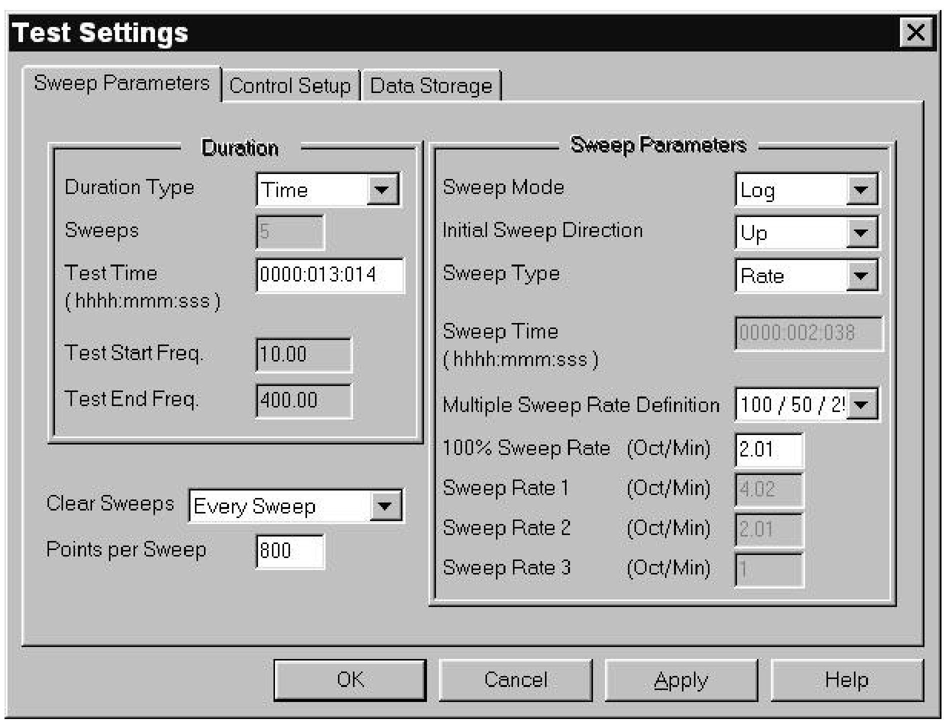


Figure 4-5. Sweep Parameters Tab of Test Settings Window Set for Time

Table 4-3. Sweep Parameter Group Box Text Box Labels

Sweep Time (hhh:mmm:sss)	100% Sweep Rate (Oct/Min)	Sweep Rate 1 (Oct/Min)	Sweep Rate 2 (Oct/Min)	Sweep Rate 3 (Oct/Min)

The user may either define a file through the **Test Settings** Dialog Box tabs or load a file directly through the **FILE** Menu options (see Chapter 3).

4.2.2.1.2 Control Setup

The ***Control Setup*** Tab (Figure 4-6) has two toggle button boxes and a text box. They are described below.

Strategy – Allows user to assign the control strategy to be applied to the test. The choices are: *Average, Minimum*, *Maximum* or *RMS.* Selection of one dictates how much of the individual control channel level is to be computed and used as the composite control level. **Average** is the default

Mode - This box can be set to *Manual*, *Automatic* or *Auto Only*. If Auto Only is selected the manual mode may not be initiated once the test starts.

Compression % - Compression controls the amount of drive correction utilized when an error exists between the reference and control. The higher the compression, the more correction (based on the control error) is utilized. You could consider a 0% compression to be the same as a "fixed" drive output level. Also, 100% does not mean the entire error is corrected since that usually leads to an unstable control loop. The term dates back to analog sine controllers but the function is essentially the same. For our digital controllers, the correction feedback is also tempered (somewhat) based on the drive frequency and ultimately by optional user scheduling.

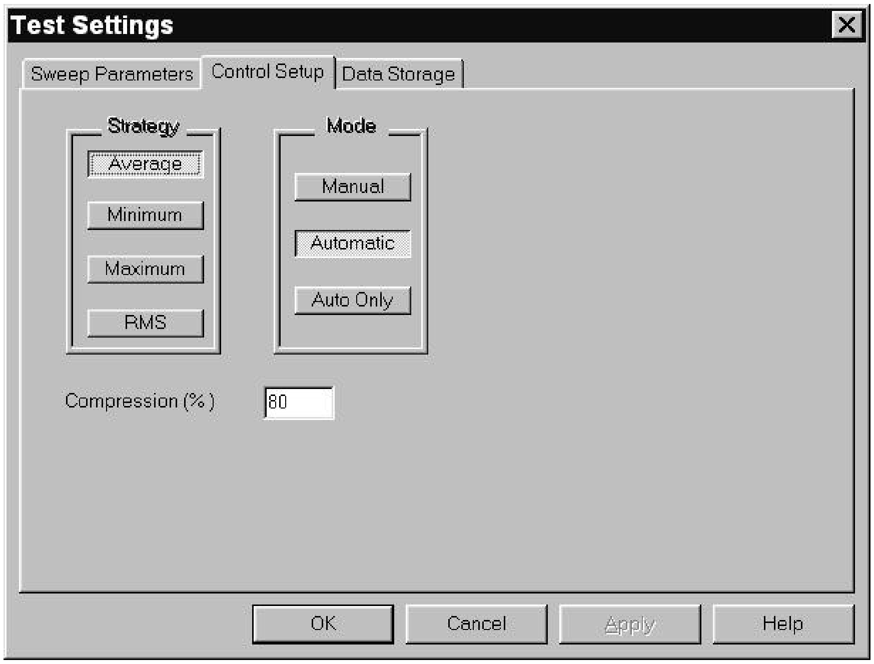


Figure 4-6. Control Setup Tab of Test Settings Window

4.2.2.1.3 Data Storage

The ***Data Storage*** Tab (Figure 4-7) has one toggle button box, four check boxes and two text boxes.

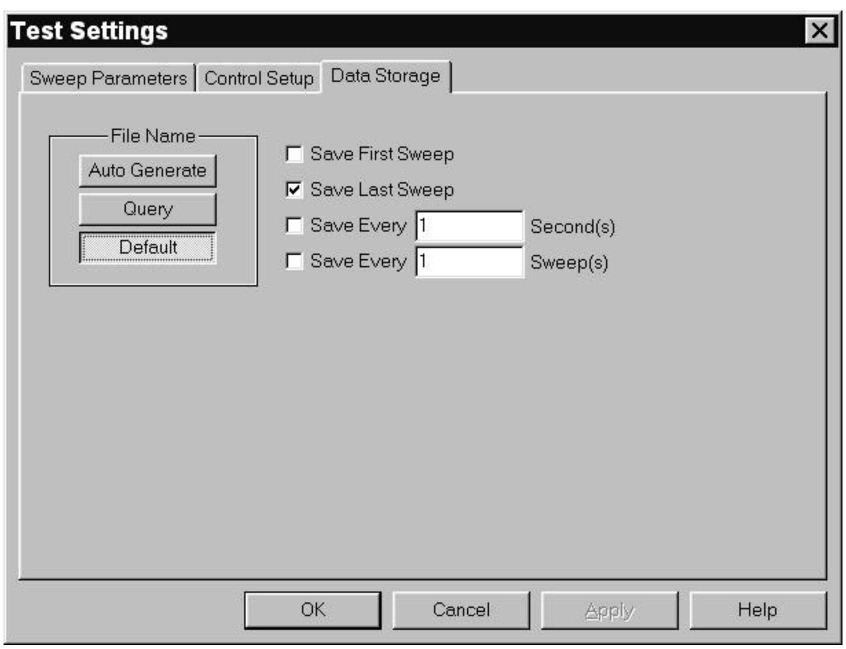


Figure 4-7. Data Storage Tab of Test Settings Window

File Name Toggle Button Box – Defines the way the file name will be generated. The toggle buttons are:

- *Auto Generate* - Creates a unique file name based on the day, date and time that the test started.
- *Query* - Prompts user for a file name after starting test.
- *Default* – All test data is saved in a default file. The default file is overwritten each time the test starts.

Check Boxes

Save First Sweep – Saves a frame of data at the tests first sweep.

Save Last Sweep – Saves a frame of data at the tests last sweep.

Save Every (X) Second(s)

Save Every (X) Sweep(s)

4.2.3 Profiles

The **PROFILES** Menu Option displays the **Profile Settings** Window. See Figure 4-8.

4.2.3.1 Profile Settings Control Tab

The top section is comprised of a scroll bar and 11 columns, nine of which can receive input for test parameters. The left two columns show the profile number (1-500) and the **Status**, which indicates whether the profile is ON or OFF. At the top of the profile number column is a printer icon, which enables the user to print out the **Profile Settings *Control* Tab.**

The middle area is comprised of three sections labeled **Reference Parameters**, **Alarm**-**Abort Range** and **Units Selection**. The Reference Parameters section has two text boxes. To the right is a two-text box group labeled Alarm-Abort Range. They list the minimum and maximum frequency for that range. Below is the Units Selection section, which offers a choice of measurement between inches and millimeters. The bottom section has a **File Selection Box**. Just to the left is a graph window that displays the test profile reflecting the parameters input by the user.

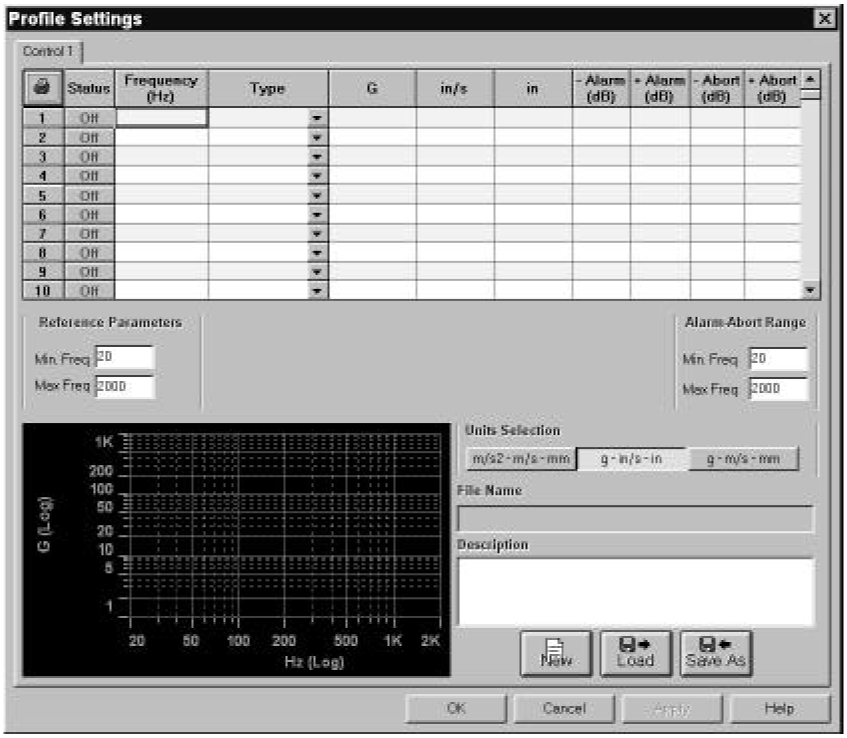


Figure 4-8. Profile Settings Control Tab

4.2.4 Schedules

The **S̲CHEDULES** Menu Option displays the **Schedule Setup** Window. It has one tab labeled ***Sine Schedule*** (Figure 4-9) discussed below.

4.2.4.1 Schedule Setup

This tab has four standard Windows command buttons visible at the bottom of the tab(s). They are: <*OK*>, <*CANCEL*>, <*APPLY*> and <*HELP*>. Please refer to Windows documentation for the use of these buttons.

4.2.4.1.1 Sine Schedule Tab

The ***Sine Schedule*** Tab format displays two areas of information. On the upper left side is a **multi-box group**. It consists of five text boxes and a check box. The text box labels are:

- Test Start Frequency
- Test End Frequency
- Start Up Rate (dB / sec)
- Shut Down Rate (dB / sec)
- Test Level (-dB)

The check box label is: Auto Start Test When Level Reached.

On the bottom left side is a **File Selection Box**.

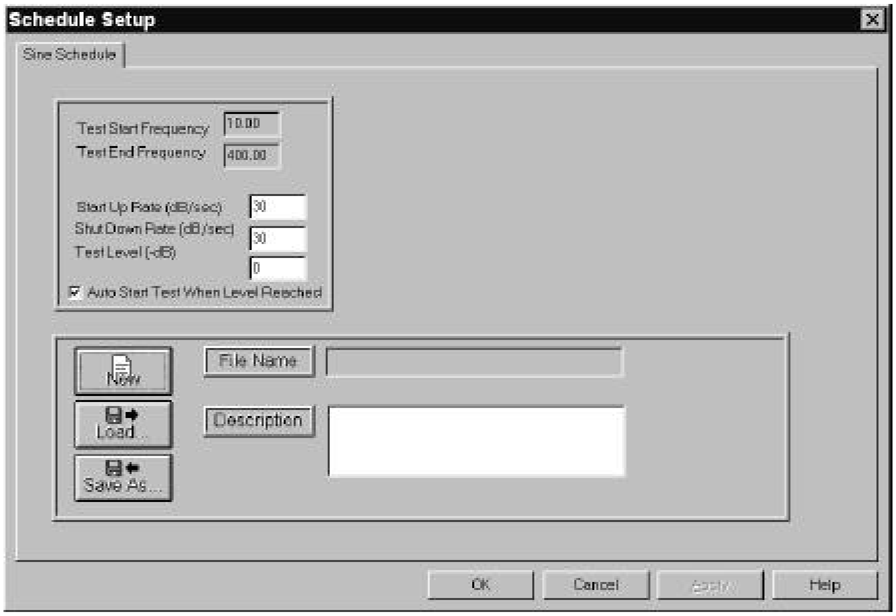


Figure 4-9. Sine Schedule Tab of Schedule Setup Window

4.2.5 Limits

The **LIMITS** Menu Option displays the **Limit Settings** Window. It has two tabs labeled ***Safety Limits*** (Figure 4-10) and ***Shaker Limits*** (Figure 4-11). Both are discussed below.

4.2.5.1 Limit Settings

Both tabs of the Limit Settings Window have four standard Windows command buttons visible at the bottom of the tab(s). They are: <*OK*>, <*CANCEL*>, <*APPLY*> and <*HELP*>. Please refer to Windows documentation for the use of these buttons.

4.2.5.1.1 Safety Limits Tab

The ***Safety Limits Tab*** has three group boxes.

- **Group Boxes** - The Group Boxes are labeled *Control Signal Loss*, *Abort Excursions*, and *Loop Check*. The Control Signal Loss Group Box has two text boxes labeled: **Abort Count** and **dB Below Min. Reference**.
- The. Abort Excursions text box is labeled **Count**.
- The Loop Check Group Box has three text boxes labeled **Frequency (Hz)**, **Max Noise (mVRMS)** and **Max Drive (mVRMS)**. It also has two command buttons, <*FAST*> and <*RIGOROUS*>.

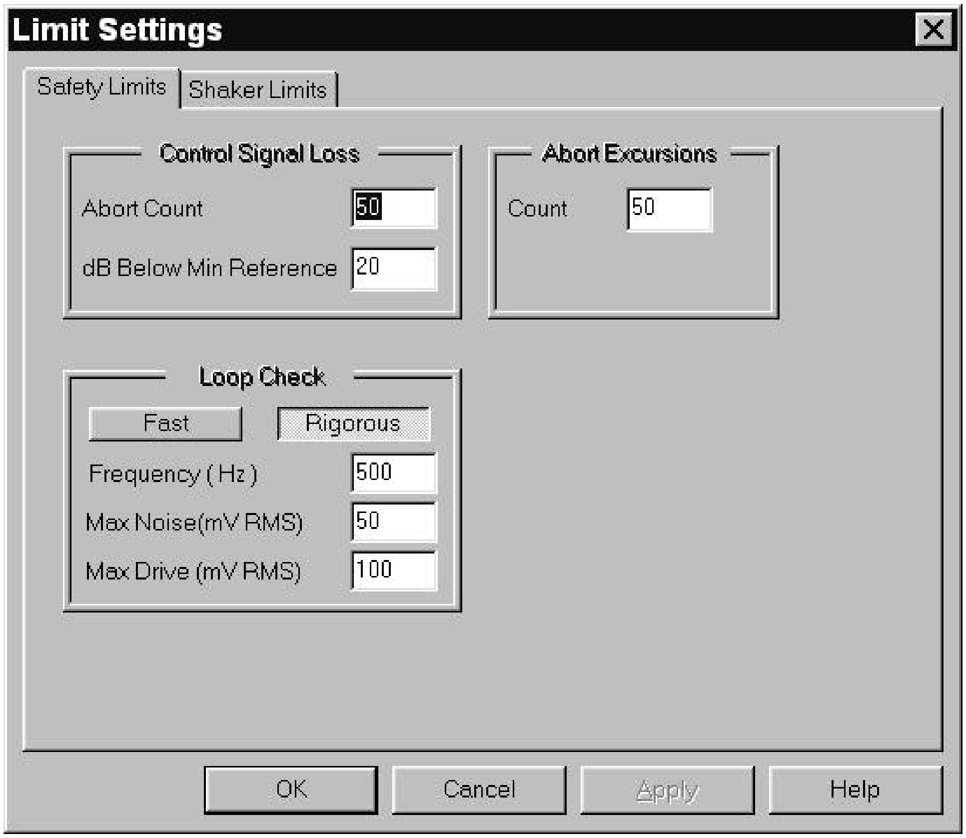


Figure 4-10. Safety Limits Tab of Limit Settings Window

4.2.5.1.2 Shaker Limits Tab

The ***Shaker Limits*** Tab of the Limit Settings Window has four sets of text boxes, a check box and an FSB. Each text box set has a box for input of either a positive or negative value. The boxes are labeled:

- Acceleration (g)
- Velocity (in/sec)
- Displacement (in)
- Voltage (V)

The check box is labeled **Symmetric Limits**. If asymmetric limits are desired, deselect the check box to access the lower limit text boxes.

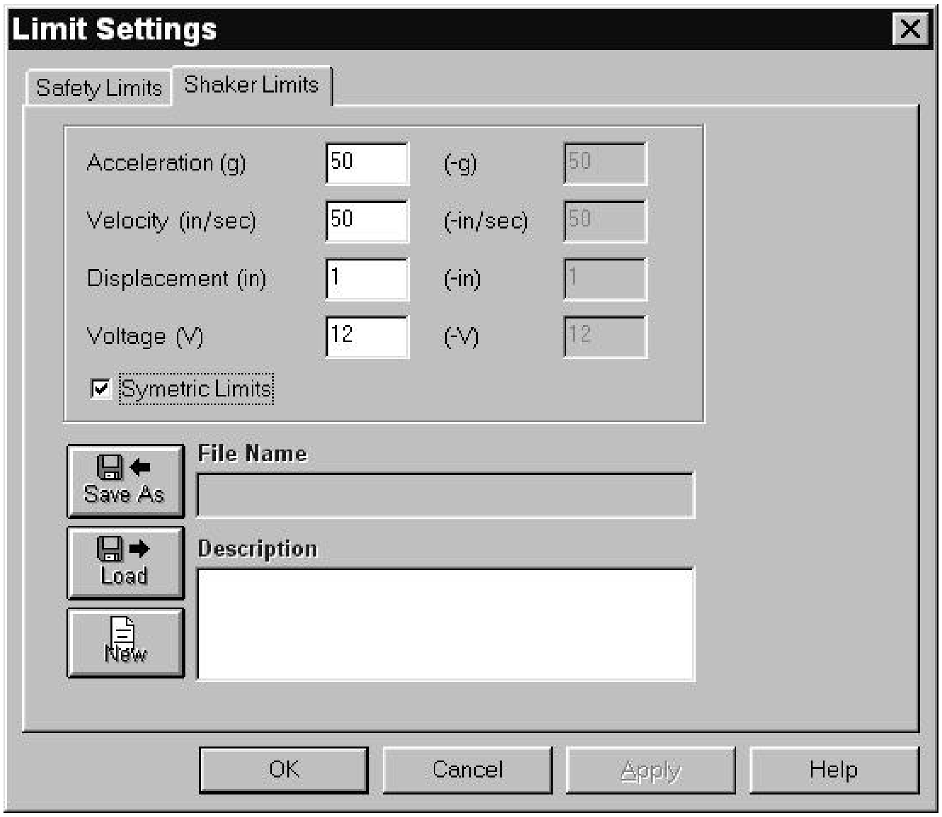


Figure 4-11. Shaker Limits Tab of Limit Settings Window

4.2.7 Remote Control Interface

The **REMOTE CONTROL INTERFACE** Menu Option allows bi-directional communication with other instrumentation. See Figure 4-12. It is explained in a Technical Manual under development.

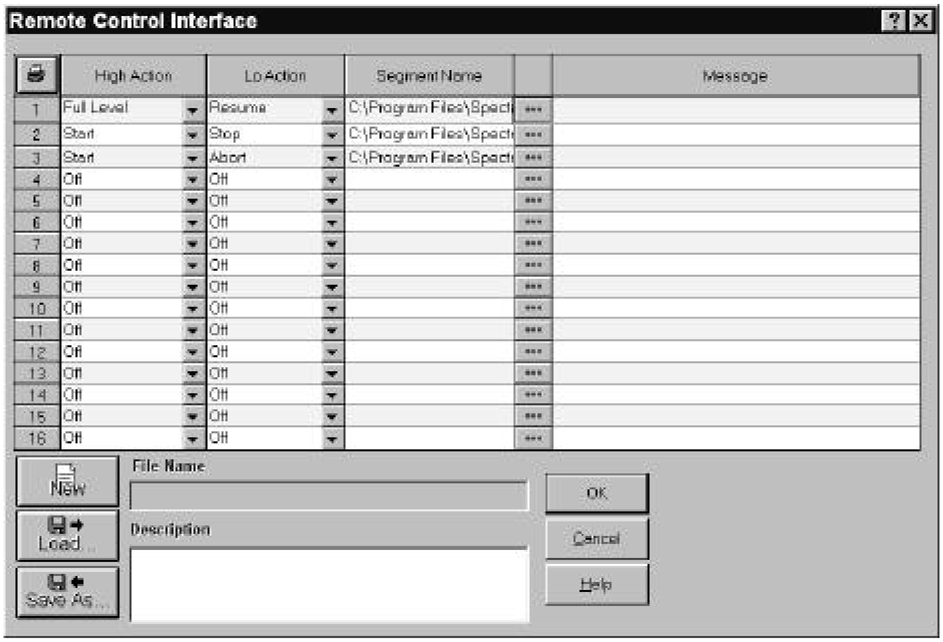


Figure 4-12. Remote Control Interface Dialog Box

4.2.8 Security

The **SECURITY** Menu Option displays the **Update Security File** Window. See Figure 4-13. This is an option. This window is used to update the security file by either adding or deleting employees names, their privileges or both.

Figure 4-13. Update Security File Window

This window has a list box with access to all employees' names, a list box with all the current privileges available to each employee, two text boxes dealing with a password and five command buttons. The <OK> and <CANCEL> are standard Windows buttons and are explained in the Windows documentation.

The other three command buttons are <ADD USER>, <DELETE USER> and <UPDATE>. The first two are self-explanatory and the last one acts like a **SAVE** menu option.

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Chapter 5 - View Menu

5.1 Introduction

The **VIEW** Menu Option has 11 sub-menus displayed in a five section drop-down menu. The top section lists six items consisting of a toolbar, a status bar, controls and indicators. The remaining sections each have one sub-menu available. When **VIEW** is selected from the Menu Bar, the image shown in Figure 5-1 will display. The checkmarks indicate items that will be presented either in a window or on the desktop during the test.

5.2 View Sub-Menus

Each of the remaining **VIEW** sub-menu items are described next.

5.2.1 Toolbar And Status

Bar When the **TOOLBAR** and/or **STATUS BAR** options are selected (Figure 5-1), the Toolbar buttons and Status Bar information will display. See Figure 5-2.

5.2.1.1 Toolbar

The **TOOLBAR** buttons are shortcuts for various menu items. The first six, and the last three, are standard Windows Toolbar buttons. These are described in the users Windows documentation. Information for the other three buttons, **CHANNEL SETUP, PROFILE SETTINGS**, and **SETUP SCHEDULE**, can be found later in this chapter.

5.2.1.2 Status Bar

The Status bar gives information about various activities currently running on the system. A message displays whenever the cursor touches a shortcut icon with the exception of the **PROFILE SETTINGS** and **Setup Schedule** icons. It also has three boxes that act as text boxes to indicate certain functions are available.

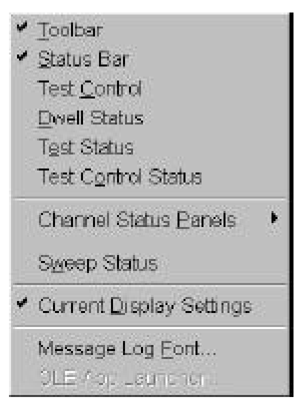

Figure 5-1. View Menu

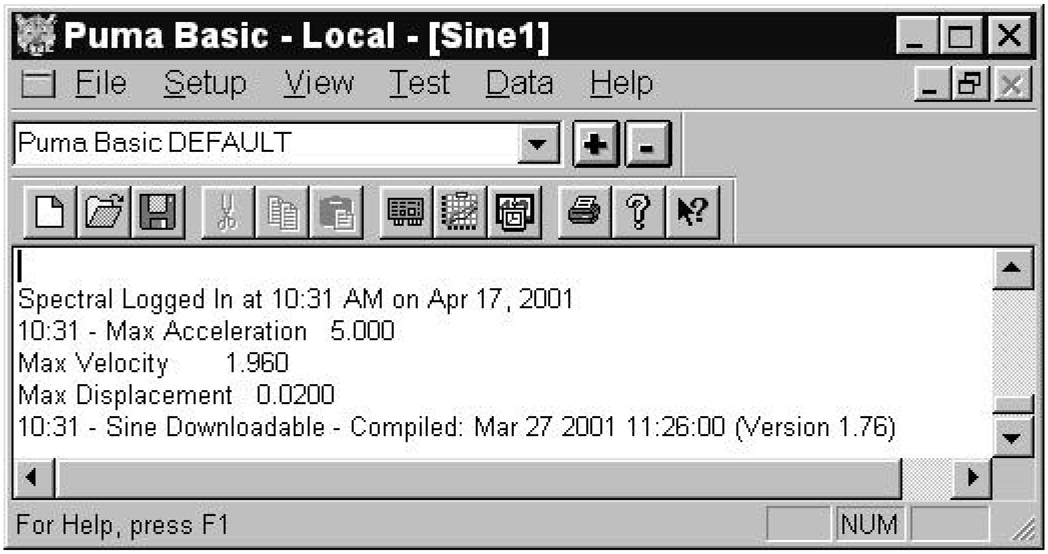

Figure 5-2. Toolbar, Status Bar Current Display Settings and Message Log

5.2.2 Test Control

When **TEST CONTROL** is selected from the **VIEW** menu, the Test Control (TC) shown in Figures 5-3 & 5-4 will display. The TC, described next, has nine buttons and two sliders used to control the test.

5.2.2.1 Start / Stop

Click the <Start> button to begin the currently loaded test. After starting the button label changes to read **Stop**.

5.2.2.2 Save

Click the <Save> button to save the current frame of data to a file.

5.2.2.3 Manual

Select the <Manual> button to run the test in the manual mode. The **TC** text boxes will display the numeric values of its slider bar(s).

NOTE: Manual Mode must be enabled to work any of the following buttons.

5.2.2.4 Dwell

The <Dwell> button causes the sweep to pause.

5.2.2.5 Sweep Up

The <Swp Up> button causes the sweep to be up.

5.2.2.6 Sweep Down

The <Swp Down> button causes the sweep to be down.

5.2.2.7 Sliders

The sliders are used to adjust the compression or amplitude.

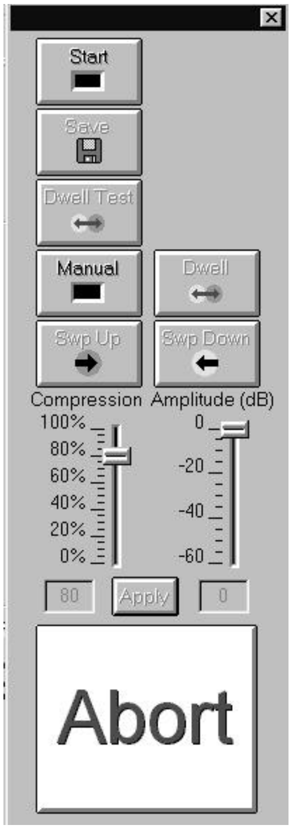

Figure 5-3. Test Control Tool
Before Test

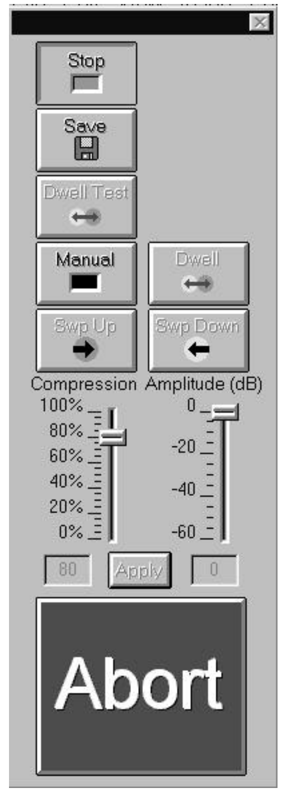

Figure 5-4. Test Control Tool
During Tes

5.2.2.8 Apply

The <Apply> button causes the changes made to be applied to the test.

5.2.2.9 Abort

Select the <Abort> button to abort the currently running test.

5.2.3 Test Status

When the **TEST STATUS** option from the **VIEW** menu is selected, the window shown in Figure 5-5 displays. It shows the test status, elapsed time elapsed sweeps of the currently loaded test and a progress bar to show the approximate percentage of test completion.

The **Test Status** Box displays different messages according to what is being done at the time. Table 5-1 lists the messages.

Table 5-1. Test Status Box Messages.

PreTest	Ramping Up	Loop Check
Running	Running Manual	Running Auto
Stopped	Ramping Down	Abort

The **Running** message displays upon reaching the preset operating level. After clicking on the <Manual> button, the message will indicate either Manual or Auto, depending on the mode being run.

Figure 5-5. Test Status Box

5.2.4 Test Control Status

When the **TEST CONTROL STATUS** option from the **VIEW** menu is selected, the window shown in Figure 5-6 displays. It shows the test frequency, control level and drive level of the currently loaded test.

Figure 5-6. Test Control Status

5.2.5 Channels Status Panels

When **CHANNEL STATUS PANELS** option (**CHANNELS 1 TO 4**) are selected, the activated Channel Status Box is displayed. See Figure 5-7. These give G force information about the channels being used. The measurement is to the nearest one thousandth.

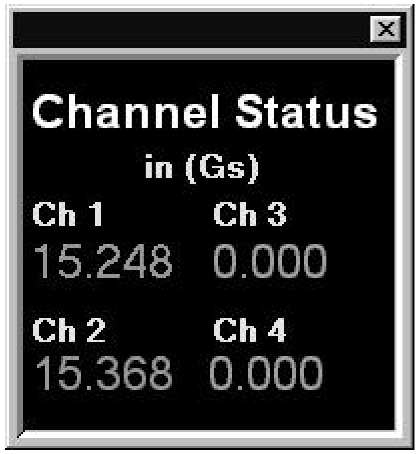

Figure 5-7. Channel Status Box

5.2.6 Sweep Status

The Sweep Status Box is divided into two sections. See Figure 5-8. The upper one has a graphic indicator above the octave per minute rate of the test. The three graphics are:

A check mark to indicate the loop check is in progress

Arrows pointing up, down, left and right. The arrow up indicates ramping up; if down it indicates ramping down. An arrow pointing to the right indicates the sweep up and when pointing to the left it indicates the sweep down

A hand indicates the test is on hold (dwell / pause)

The lower section of the box has three Sweep Rates Buttons:

- Quarter
- Half
- Full

These buttons are only available in the Manual mode.

Figure 5-8. Sweep Status Boxes

5.2.7 Current Display Settings

When the **CURRENT DISPLAY SETTINGS** Option is checked The Puma Basic Desktop Toolbar appears. See Figure 5-2. It indicates which .slg file layout is currently being used.

5.2.8 Message Log Font

When **MESSAGE LOG FONT** is selected from the **VIEW** menu, a standard Windows Font Dialog Box appears. See Figure 5-9. Refer to the Windows documentation for further information. The Message Log is shown in Figure 5-2.

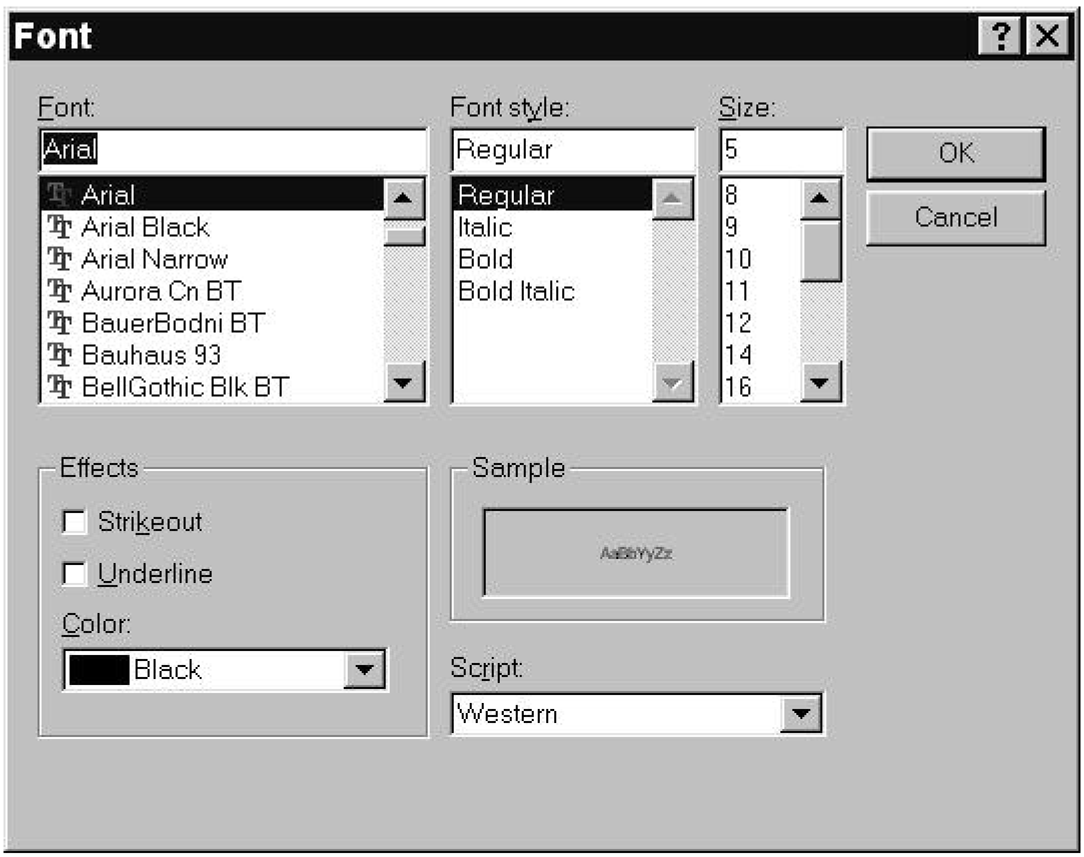

Figure 5-9. Windows Font Dialog Box

Chapter 6 - Test Menu

6.1 Introduction

Depending on when the **TEST** option is selected from the Sine Menu, the images shown in Figures 6-1 through 6-3 may display.

Figure 6-1. Test Menu Options Prior to Test Parameter Input

Figure 6-2. Test Menu Options After Parameter Input Before Start of Test

Figure 6-3. Test Menu Options During Auto Operation

6.2 Test Sub-Menus

Each of the items on the **TEST** menu is described in the following paragraphs. Use of these sub-menus allows the user to refrain from having to repeatedly hide or recall the Test Control, which is available in the View Menu Option (Chapter 5). The checkmarks indicate that the menu option is active when available

6.2.1 Abort

The **ABORT** menu option allows the user to stop the test immediately in case of a problem. After the problem is corrected the test may be resumed. See Figure 6-4.

Figure 6-4. Test Menu Options available after an ABORT or STOP Selection

6.2.2 Start

The **START** menu option becomes available to start the test if either of two criteria has been met:

9. A previous test file has been loaded
10. Test parameters have manually been input for all required phases of the test. After the test has started, the menu options change. Those available are shown in Figure 6-3. The **START** option changes to read **STOP**. After the test is completed the options in Figure 6-2 are available.

6.2.3 Restart

The **RESTART** menu option is only available after a test has been stopped. It allows the user to restart the test from the same point that the test was stopped with a **STOP** (Figure 6-4) or **ABORT** menu option. When activated, the **Restart Parameters** Dialog Box appears. See Figure 6-5. Input the required parameters and click <OK>.

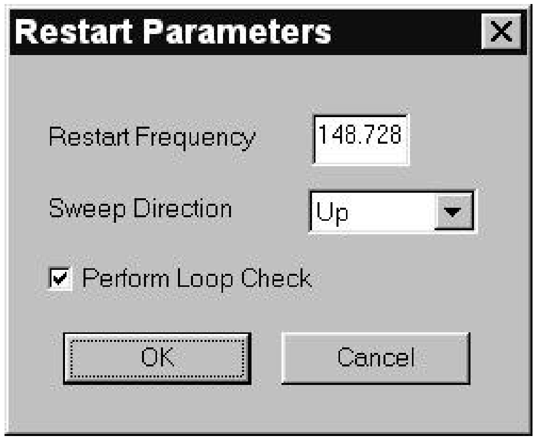

Figure 6-5. Restart Parameters Dialog Box

6.2.4 Manual

The **MANUAL** menu option allows the user to take manual control of the test so that parameters other than the ones originally started with can be used. See Figure 6-6.

Figure 6-6. Test Menu Options in MANUAL MODE

6.2.5 Dwell

The **DWELL** Menu Option allows the user to place a hold on the sweep. See Figure 6-7. After the Dwell is initiated the menu options change again.

Figure 6-7. Test Menu Options after clicking DWELL

6.2.6 Sweep Up

The **SWEEP UP** menu option allows the user to manually step up the sweep while in the manual mode. See Figures 6-6.

6.2.7 Sweep Down

The **SWEEP DOWN** menu option allows the user to manually step down the sweep while in the manual mode. See Figure 6-6.

6.2.8 Full

The **FULL** Menu Option allows the user to set the sine wave to the full amplitude in the manual mode. See Figures 6-6.

6.2.9 Half

The HALF Menu Option allows the user to set the sine wave to half amplitude in the manual mode. See Figures 6-6.

6.2.10 Quarter

The **QUARTER** Menu Option allows the user to set the sine wave to quarter amplitude in the manual mode. See Figures 6-6.

6.2.11 Save

The **SAVE** menu option allows the user to save the test as a file to be used at a later time. This option is only available after new test parameters or a previous test has been loaded. It is also available during the test.

6.2.12 Message Log

The Message Log is the file of information being generated and is displayed as the test is running. The Message Log submenu has submenus of its own. There is a Message Priority selection with three submenus for it. The submenus are discussed below.

6.2.12.1 Message Priority

The **MESSAGE PRIORITY** Menu Option offers the user three levels of Message Priority: High, Medium and All.

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Chapter 7 - Data Menu

7.1 Introduction

When the user selects the **DATA** Menu Option the menu shown in Figure 7-1 will display.

Figure 7-1. Data Menu Options Prior to and after Parameter Input

The **DATA** menu consists of: **DISPLAY**, **CHOOSE REPORT** and **FILE SUMMARY INFO**. Each of these menu items is described in the following paragraphs.

7.2 Data Sub-Menus

The three available **DATA** sub-menus are discussed below.

7.2.1 Display

After the required parameters are input and the test has been started, the **DISPLAY** menu option reads: *Display SineTestData.syn*. See Figure 7-2. Clicking the menu option displays the Test Data Synopsis File Notepad shown in Figure 7-3. If the parameters have not yet been saved the test name will be a synopsis file (*.syn).

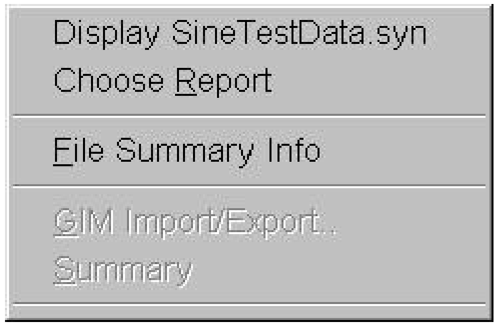
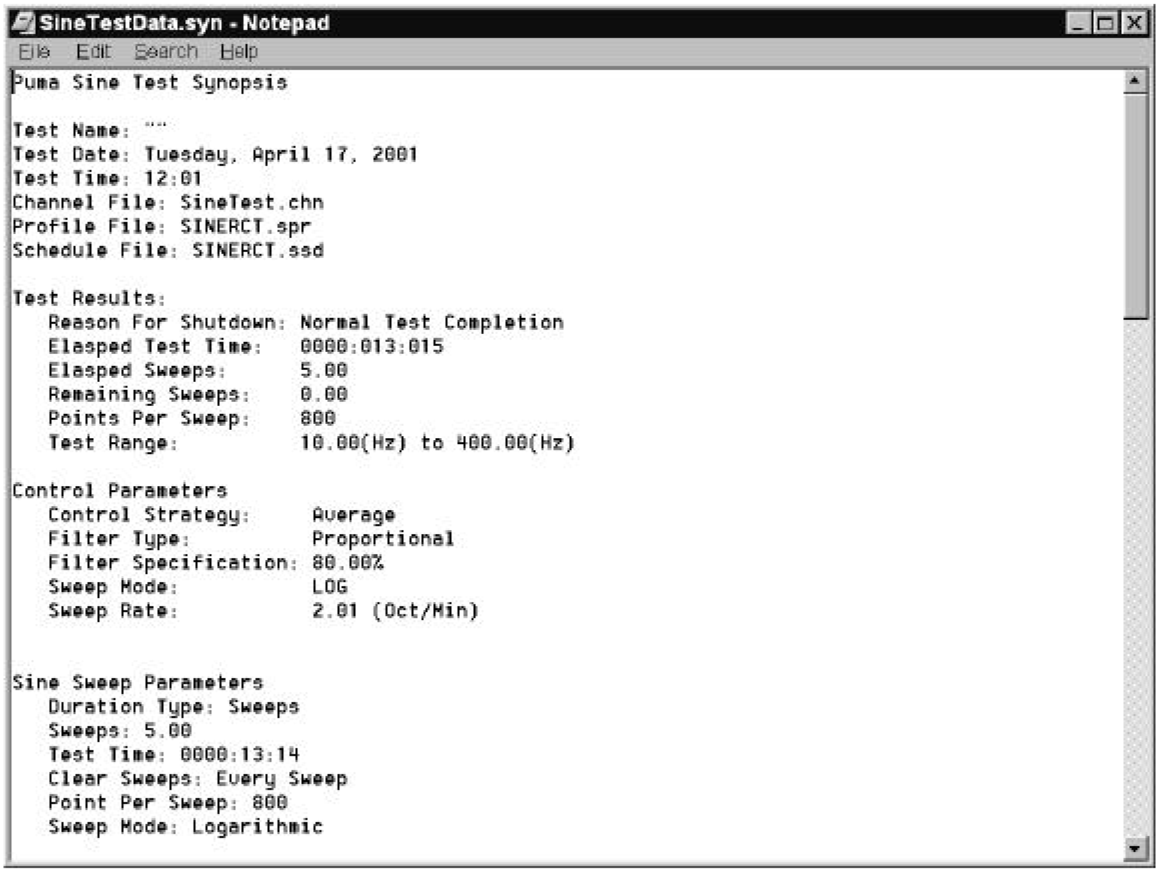


Figure 7-2. Data Menu Options During Test




```
Puma Sine Test Synopsis

Test Name: ""
Test Date: Tuesday, April 17, 2001
Test Time: 12:01
Channel File: SineTest.chn
Profile File: SINERCT.spr
Schedule File: SINERCT.ssd

Test Results:
   Reason For Shutdown: Normal Test Completion
   Elasped Test Time:   0000:013:015
   Elasped Sweeps:      5.00
   Remaining Sweeps:    0.00
   Points Per Sweep:    800
   Test Range:          10.00(Hz) to 400.00(Hz)

Control Parameters
   Control Strategy:     Average
   Filter Type:          Proportional
   Filter Specification: 80.00%
   Sweep Mode:           LOG
   Sweep Rate:           2.01 (Oct/Min)


Sine Sweep Parameters
   Duration Type: Sweeps
   Sweeps: 5.00
   Test Time: 0000:13:14
   Clear Sweeps: Every Sweep
   Point Per Sweep: 800
   Sweep Mode: Logarithmic
```

Figure 7-3. Sine Test Data Synopsis File Notepad

7.2.2 Choose Report

The **CHOOSE REPORT** option activates a standard Windows **Open** File Dialog Box, which allows the user to search for and select the file that contains the report information required.

7.2.3 File Summary Info

When the user selects the **FILE SUMMARY INFO** option, the **Document Properties** Dialog Box shown in Figures 7-4 and 7-5 will display. It has two index tabs, labeled: ***Summary***, and ***Statistics***. They are used primarily to annotate the file information. At the bottom are the standard Windows buttons <*OK*>, <*Cancel*>, <*Apply*>, and <*Help*>. For further information about these buttons see the Windows documentation.

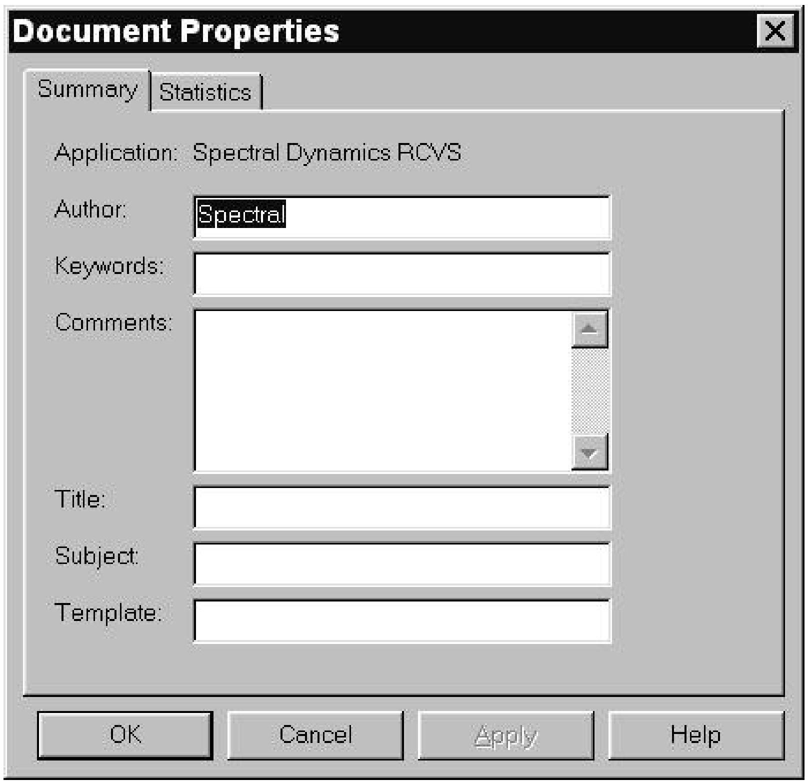


Figure 7-4. Summary Index Tab

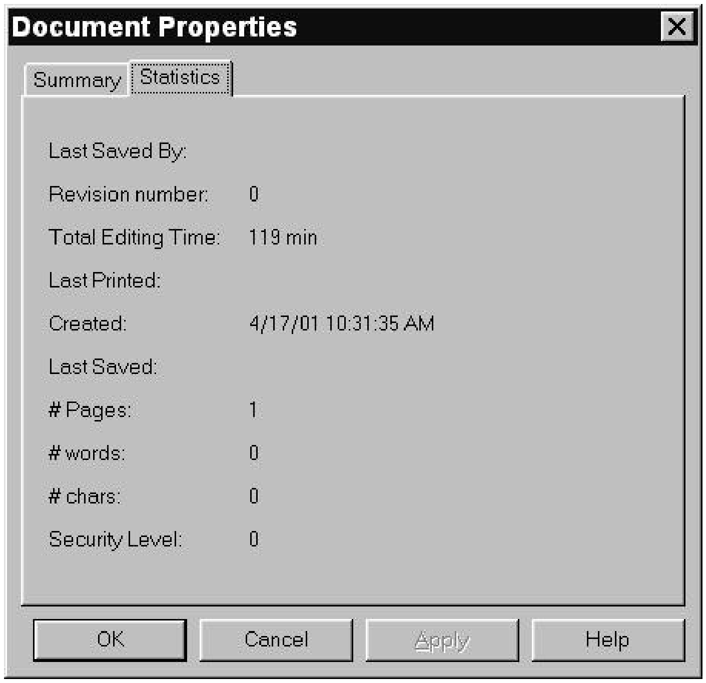


Figure 7-5. Statistics Index Tab

7.2.3.1 Summary Tab

The ***Summary*** Index Tab contains seven fields. The first field Application, names the software program that is currently loaded. The other six fields Author, Keywords, Comments, Title, Subject and Template allow the user to add summary information.

7.2.3.2 Statistics Tab

Figure 7-5 displays, the ***Statistics*** Index Tab information. It lists ten lines of basic information about when the file was created, how large it is, and so forth.

Chapter 8 - Help Menu

8.1 Introduction

When the user selects the **HELP** Menu Option from the Sine menu bar, the menu shown in Figure 8-1 will display. This menu consists of **HINTS**, **SUPPORT** and **ABOUT PUMA BASIC.**

Figure 8-1. The Help Menu

8.2 About PUMA

The About PUMA Basic Window (Figure 8-2) features a rolling, bouncing cube with pictures of a Puma and the CATS PUMA logo. The right side of the window displays version, build and copyright information.

Figure 8-2. Help Menu's ABOUT PUMA BASIC Screen

PUMA BASIC

Sine
Operating Manual

2400-0124a
Change 1

May 15, 2001